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MINERAL RESOURCES OF THE UNITED STATES, 1928—PART I

THE MINERAL RESOURCES OF THE UNITED STATES IN 1928¹

INTRODUCTION

BY FRANK J. KATZ

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This report, the forty-sixth of an annual series, is published in two parts. Part I contains a general summary of all mineral products, the prefatory note to the chapters on gold, silver, copper, lead, and zinc giving average prices at which values of the metals are calculated, and 31 chapters of which 15 are State or regional reports relating to gold, silver, copper, lead, and zinc mining and 16 are general reports on various metals or metalliferous mineral products. Part II consists of 30 chapters, each relating to one, or a group, of the nonmetallic mineral products, including the mineral fuels—coal, oil, and gas.

The summary which constitutes the first chapter of Part I comprises: (1) General summary tables of production; (2) detailed tables giving data on domestic production and on imports and exports of the various minerals, arranged in alphabetic order, for a series of years, and giving data on consumption, stocks, etc., for some important products; (3) State tables in alphabetic order. Thus, it is a recapitulation of the statistical material contained in both volumes of Mineral Resources of the United States.

Unit of measurement.—The unit of measurement used by the Bureau of Mines for each mineral product in the reports on the mineral resources is that common to the industry concerned, and the variation in these units makes it impracticable, if not impossible, directly to combine and compare the different minerals except as to value, especially because some products are measured by volume, although most are measured by weight.

Elimination of duplication.—In the totals for the United States, shown in the following general tables, duplication has been eliminated wherever practicable, and in the State totals given in the State tables virtually all duplication has been eliminated. For instance, in both general and State tables the output of coke is shown, but its value is not included in the totals, as the value of the coal used in its manufacture enters into the value of the coal production, which is included in the totals. The value of the products of the clay industries is

¹ In Mineral Resources of the United States the use of leaders (....) indicates that so far as the Bureau of Mines has been able to ascertain there was nothing to report. If data are not available, the fact is indicated by a statement to that effect in a footnote. Leaders are also used in footings where it is quite evident that figures in a column are not addable and in other places where entries are not appropriate.

All figures of imports and exports in this report, unless otherwise stated, were compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce, having been converted by Mr. Dorsey to the various units of measurement used in this report and arranged by him in their present form. The imports are those for the calendar year unless otherwise stated. Wherever exports are shown, unless otherwise specified, the figures represent domestic products and not foreign minerals reexported, and they also cover calendar years.

included in both general and State totals as representing the first marketable form of the greater part of the clay produced; the quantity and value of the clay mined and sold in the raw state by miners to manufacturers of clay are shown separately, but the value is not included in the totals.

In the general tables both iron ore and pig iron are shown, but the value of the pig iron rather than that of the iron ore is included in the totals, as that is considered the better means of presenting the statistics for iron in its first marketable form. For gold, silver, copper, lead, and zinc the value of "smelter output" is included in the general totals, and in order to account more fully for the value of the ores treated these smelter figures are supplemented by the value of the by-product sulphuric acid. The value of pigments (white lead, red lead, lithopone, litharge, and orange mineral) manufactured from metals are not included in the general tables, as the base from which they are made is included in the output of lead or zinc, whereas the value of sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide are included, as these are made in large part direct from the ores and do not enter into the lead or zinc totals, which represent smelter output.

In the State tables also iron ore and pig iron are both shown. As blast-furnace products can not be distributed according to the States in which the ore is mined, the value of the ore is used in the State totals. For ores of gold, silver, copper, lead, and zinc no values are shown, and in fact none are recorded; instead, for each of these metals the recoverable content of the ores is used as the basis of valuation. The value of the zinc and lead pigments is not included in the State total, as the recoverable zinc and lead content of the ores from which the products were made is included under zinc or lead. The value of the sulphuric acid produced as a by-product of copper and zinc smelting is not included in the State total, as tracing this product back to the State producing the ore has not been possible.

SALIENT FEATURES OF 1928 STATISTICS

The year 1928 with respect to the combined output of all mineral products may be characterized as one of little change and that in the direction of slightly lower rates of production and price levels. The total value of all products in 1928 (\$5,384,400,000) was 3 per cent less than the corresponding value (\$5,530,000,000) in 1927 and 13 per cent less than that in 1926. Similar comparison for the various individual mineral products, however, shows diverse departures from the common trend, both in the quantities and values. For some branches of the industry changes were striking and there were some notable increases.

The mineral fuels, as a group, showed a decrease of nearly 6 per cent in total value of products, attributable chiefly to the decrease in petroleum and in bituminous coal, although anthracite shared in the decline; natural gas and its coproducts increased. The year 1928 was the second successive year during which less coal, both anthracite and bituminous, was mined than in the preceding year. Value of output decreased somewhat more than quantity, thus reflecting the decline in prices. Production of crude petroleum established a new high record in 1928, totaling slightly more than in 1927. Domestic demand for all oils was considerably greater than in

1927; hence stocks increased less, and at the end of the year there was a better balance between supply and demand. The value of the 1928 output was materially less than that of 1927. Gasoline production in 1928 showed a marked increase in quantity and still larger increase in value over 1927. The natural gas output continued to grow.

The total value of metallic products of the mines of the United States in 1928 was about 5 per cent greater than that in 1927 but was well below the value in 1926. Copper, iron, and aluminum accounted for the gain. The increase in production of aluminum was large, and despite a decline in price the total value of the output increased 22 per cent. A new all-time record was established by the total refined copper output of the United States in 1928 and a new peace-time record by the smelter output. Moderate rate of production and lower price prevailed at the beginning of the year, but in response to increasing demand both gained throughout the year. In contrast, lessened demand for lead was reflected in the decrease in price and the consequent decrease in quantity and value of lead production. The price of zinc also averaged less for 1928 than for 1927 but had an upward trend during 1928. Production was steady as compared with a falling rate throughout the preceding year, and the total quantity was slightly greater but had a lower aggregate value than that in 1927. The production of steel in 1928 reached a new peak, but the output of pig iron and iron ore, although larger than in 1927, was considerably below the record years. The production of manganese ore increased slightly over 1927, and the value was also slightly higher. Stimulated by high prices, the production of mercury in the United States in 1928 gained 61 per cent in quantity and 68 per cent in value. Gold production increased 1.6 per cent. Silver production decreased 3 per cent, but the average price was higher in 1928 than in 1927 and the decrease in total value was slight.

The total value of nonmetallic mineral products (not including fuels) in 1928 decreased 3 per cent as the result of a general decline in prices which offset prevailing increases in quantity of production. There were a few notable exceptions, however. Among the structural materials sand and gravel production increased in both quantity and value; both lime and cement production increased slightly in quantity but decreased in value; stone production decreased slightly in both quantity and value; and gypsum production decreased about 5 per cent in quantity but about 24 per cent in value. Among the ceramic materials clay showed increase in both quantity and value; feldspar showed moderate increase in quantity but diminished total value of product; and silica showed practically no change in output. The chief fertilizer ingredients—phosphate rock and potash—increased markedly in both quantity and value of production, as did also salt, but sulphur shipments were only a trifle greater in quantity and were slightly less in value in 1928 than those in 1927, and pyrites production was markedly reduced in quantity and greatly in value. The quantity of fluorspar produced showed a large increase, chiefly in response to requirements for steel manufacture, and the total value of the output increased in even greater ratio. Graphite also showed a large increase in value. Other industrial minerals that showed an increase in quantity with a lesser increase in value were arsenic, barite, fuller's earth, and magnesite.

STATISTICAL SUMMARY

By MARTHA B. CLARK

GENERAL TABLES

Mineral products of the United States, 1927 and 1928¹

Product	1927		1928	
	Quantity	Value	Quantity	Value
METALLIC				
Aluminum.....pounds.....		\$39,266,000		\$47,899,000
Antimonial lead ² short tons (2,000 pounds).....	24,347	3,277,043	33,058	3,978,318
Antimony ³ do.....	2,736	675,800	3,432	707,000
Bauxite.....long tons (2,240 pounds).....	320,940	1,988,780	375,426	2,273,898
Cadmium.....pounds.....	1,074,654	645,000	1,875,896	1,144,297
Chromite.....long tons.....	201	5,063	660	14,807
Copper, ⁴ sales value.....pounds.....	1,684,040,983	220,609,000	1,825,900,393	262,930,000
Ferro-alloys.....long tons.....	646,749	55,163,574	794,695	66,578,039
Gold ⁵ troy ounces.....	2,197,125	45,418,600	2,233,251	46,165,400
Iron:				
Ore ⁶ long tons.....	61,232,473	⁶ 151,125,820	63,432,826	⁶ 155,788,657
Pig.....do.....	34,866,644	646,226,139	38,303,699	661,351,270
Lead (refined), ⁴ sales value.....short tons.....	668,320	84,208,000	626,202	72,639,000
Manganese ore (35 per cent or more Mn).....long tons.....	44,741	1,151,918	46,860	1,214,853
Manganiferous ore (5 to 35 per cent Mn) ⁷ long tons.....	1,461,608	3,947,016	1,177,632	3,053,307
Mercury:				
Metal.....flasks (75 pounds net).....	11,276	1,314,782	18,108	2,207,003
Ore.....short tons.....	(⁸)	(⁸)	(⁸)	(⁸)
Nickel (value at New York City).....do.....	860	390,740	522	291,836
Ores (crude), tailings, etc.:				
Copper.....do.....	56,826,000	(⁹)	62,125,000	(⁹)
Copper-lead and copper-lead-zinc.....do.....	419,000	(⁹)	351,000	(⁹)
Dry and siliceous (gold and silver).....do.....	8,550,000	(⁹)	8,095,000	(⁹)
Lead.....do.....	8,349,000	(⁹)	8,048,000	(⁹)
Lead-zinc.....do.....	14,647,000	(⁹)	13,379,000	(⁹)
Zinc.....do.....	6,823,000	(⁹)	5,855,000	(⁹)
Platinum and allied metals (value at New York City).....troy ounces.....	46,050	3,780,216	59,039	4,692,786
Silver.....do.....	60,434,441	34,266,328	58,462,507	34,200,567
Tin (metallic equivalent).....short tons.....	27	34,600	47	47,400
Titanium ore:				
Ilmenite.....do.....	3,500	44,000	(¹⁰)	(¹⁰)
Rutile.....do.....	(¹⁰)	(¹⁰)	(¹⁰)	(¹⁰)
Tungsten ore (60 per cent concentrates).....do.....	1,164	724,000	1,208	753,900
Uranium and vanadium ores.....do.....	(¹⁰)	(¹⁰)	(¹⁰)	(¹⁰)
Zinc, ⁴ sales value.....do.....	576,960	73,851,000	591,525	72,166,000
Total value of metallic products (approximate).....		1,217,700,000		1,284,580,000
NONMETALLIC				
Arsenious oxide.....short tons.....	11,560	725,360	11,767	735,373
Asbestos.....do.....	2,981	336,882	2,239	351,178
Asphalt:				
Native.....do.....	839,040	5,605,850	807,860	5,175,055
Oil ⁶ do.....	1,525,420	⁶ 19,019,150	1,741,392	⁶ 20,425,371
Barite (crude).....do.....	254,265	1,670,878	269,544	1,754,924
Borates (colemanite and naturally occurring sodium borate).....short tons.....	109,080	3,473,399	131,000	3,999,773
Bromine.....pounds.....	1,756,310	564,689	2,164,000	649,475
Calcium-magnesium chloride.....short tons.....	95,721	1,947,797	102,090	1,995,603
Cement.....barrels (376 pounds net).....	174,023,051	281,735,676	178,051,977	278,883,042
Clay:				
Products ¹¹ do.....		403,935,547		373,550,882
Raw ⁶ short tons.....	3,849,176	⁶ 13,697,159	4,026,332	⁶ 14,200,739
Coal:				
Bituminous ¹² do.....	517,763,352	1,029,657,000	500,744,970	933,774,000
Pennsylvania anthracite.....long tons.....	71,513,896	420,941,726	67,275,062	393,637,690
Coke ⁶ short tons.....	51,092,143	⁶ 262,320,578	52,805,828	⁶ 252,833,760
Diatomite and tripoli ¹³ do.....	26,099	447,068	34,043	555,576
Emery.....do.....	506	5,855	1,341	16,787
Feldspar (crude).....long tons.....	202,497	1,424,755	210,811	1,418,975
Fluorspar.....short tons.....	112,546	2,034,728	140,490	2,656,554
Fuller's earth.....do.....	264,478	3,767,038	287,012	3,895,991
Garnet for abrasive purposes.....do.....	6,939	573,525	6,617	459,307
Gems and precious stones.....do.....		(¹⁴)		(¹⁴)
Graphite:				
Amorphous.....short tons.....	2,595	35,850	2,994	43,320
Crystalline.....pounds.....	5,224,400	197,121	5,233,300	253,773
Grindstones and pulpstones.....short tons.....	31,931	1,554,750	33,238	1,508,837
Gypsum.....do.....	5,346,888	42,174,454	5,102,250	32,036,163
Lime.....do.....	4,414,932	38,638,413	4,458,412	36,449,635

See footnotes at end of table.

Mineral products of the United States, 1927 and 1928—Continued

Product	1927		1928	
	Quantity	Value	Quantity	Value
NONMETALLIC—continued				
Magnesite (expressed as equivalent crude) short tons.....	121,490	\$1,090,550	127,200	\$1,098,550
Mica:.....				
Scrap.....do.....	6,280	110,139	7,760	132,422
Sheet.....pounds.....	1,512,492	212,482	1,681,777	230,956
Millstones.....		35,438		42,886
Mineral paints:.....				
Natural pigments ¹⁵ short tons.....	(¹⁵)	(¹⁵)	(¹⁵)	(¹⁵)
Zinc and lead pigments ¹⁶ do.....	191,853	25,275,975	202,363	26,017,743
Mineral waters.....gallons sold.....	(¹⁴)	(¹⁴)	(¹⁴)	(¹⁴)
Natural gas.....M cubic feet.....	1,445,428,000	317,930,000	1,568,139,000	363,726,000
Natural gasoline.....gallons.....	1,641,144,000	118,688,000	1,814,034,000	138,944,000
Oilstones, etc.....short tons.....	1,048	233,545	956	228,245
Peat.....do.....	(¹⁴)	(¹⁴)	(¹⁴)	(¹⁴)
Petroleum.....barrels (42 gallons).....	901,129,000	1,172,830,000	901,474,000	1,054,880,000
Phosphate rock.....long tons.....	3,170,699	11,253,352	3,501,406	12,443,179
Potassium salts.....short tons.....	¹⁷ 49,500	2,448,146	¹⁷ 60,370	3,029,422
Pumice.....do.....	53,298	221,481	57,430	278,516
Pyrites.....long tons.....	215,786	804,006	182,049	605,459
Salt.....short tons.....	7,568,690	24,817,962	8,074,700	26,772,568
Sand:.....				
Glass.....do.....	2,171,693	3,257,790	2,310,828	3,435,645
Molding, building, etc., and gravel.....do.....	195,282,576	112,271,996	206,808,040	115,772,292
Sand-lime brick ¹¹ thousands.....	319,618	3,645,842	313,553	3,654,590
Silica (quartz).....short tons.....	22,144	194,040	22,198	209,333
Slate.....do.....	692,040	11,380,736	646,360	11,472,291
Stone.....do.....	136,345,130	198,647,222	133,869,510	196,820,697
Sulphur.....long tons.....	2,072,109	38,300,000	2,082,924	37,500,000
Sulphuric acid (60° Baumé) from copper and zinc smelters.....short tons.....	1,041,399	8,234,313	1,140,268	9,007,809
Talc and soapstone ¹⁸ do.....	192,316	2,234,724	202,976	2,537,994
Total value of nonmetallic products (approximate).....		4,304,100,000		4,091,120,000
SUMMARY				
Total value of metallic products.....		1,217,700,000		1,234,580,000
Total value of nonmetallic products (exclusive of mineral fuels).....		1,244,053,000		1,206,158,000
Total value of mineral fuels.....		3,060,047,000		2,884,962,000
Total value of "unspecified" (metallic and non-metallic) products (partly estimated) ¹⁹		8,200,000		¹⁹ 8,700,000
Grand total approximate value of mineral products.....		5,530,000,000		5,384,400,000

¹ In this general statement certain of the figures represent shipments rather than quantity mined. The reader is referred to the following sections on the various mineral products for information in greater detail than it seems practicable to give here.

² From both domestic and foreign ores.

³ Figures represent antimony content of antimonial lead. Value excluded from metallic total as the value of the antimony is included in the antimonial lead value. Value for antimony other than that in antimonial lead is included in metallic total; Bureau of Mines not at liberty to publish figures.

⁴ Product from domestic ores only.

⁵ Value, \$20.671834625323 an ounce.

⁶ Value not included in total value.

⁷ Including ore used for fluxing. For separation see pp. A55 and A56.

⁸ Figures not available.

⁹ Figures showing values not available.

¹⁰ Value included in total value of metallic products; Bureau of Mines not at liberty to publish figure.

¹¹ Figures obtained through cooperation with Bureau of the Census.

¹² Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.

¹³ Figures represent tripoli only. Value of diatomite is included in total value of nonmetallic products.

Bureau of Mines not at liberty to publish figures.

¹⁴ No canvass. Estimate of value included in total value of nonmetallic products.

¹⁵ Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").

¹⁶ Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.

¹⁷ K₂O equivalent.

¹⁸ Figures represent talc only. Value of soapstone is included in total value of nonmetallic products. Bureau of Mines not at liberty to publish figures.

¹⁹ Includes for 1928 the value of bismuth, cadmium sulphide and other cadmium compounds (\$228,013), chats (\$535,000), columbite (\$26,332), flint lining for tube mills and pebbles for grinding (\$89,321), gem feldspar (\$12,000), iron ore sold for magnets, iron ore sold for paint (\$83,190), lithium minerals (\$94,750), natural magnesium salts (\$1,020,044), calcareous marl (\$200,704), greensand marl (\$207,042), micaceous minerals (\$91,197), molybdenum (\$1,924,600), selenium (\$607,382), silica sand and sandstone (finely ground) (\$1,177,637), sodium salts (carbonate, bicarbonate, sulphate, and trona) from natural sources (\$1,620,741), tellurium (\$1,731), zircon, and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Bureau of Mines.

Value of mineral products of the United States, 1880-1928

Year	Metallic		Nonmetallic		Un-specified (metallic and non-metallic)	Total	
	Value	Per-centage of in-crease or de-crease	Value	Per-centage of in-crease or de-crease		Value	Per-centage of in-crease or de-crease
1880-----	\$187,881,000	-----	\$173,582,000	-----	\$6,000,000	\$367,463,000	-----
1881-----	189,413,000	+0.8	207,207,000	+19	6,500,000	403,120,000	+10
1882-----	215,820,000	+14	230,786,000	+11	6,500,000	453,106,000	+12
1883-----	197,881,000	-8	243,680,000	+6	6,500,000	448,061,000	-1
1884-----	180,284,000	-9	221,756,000	-9	5,000,000	407,040,000	-9
1885-----	172,218,000	-4	242,333,000	+9	5,000,000	419,551,000	+3
1886-----	204,400,000	+19	250,995,000	+4	790,000	456,185,000	+9
1887-----	240,791,000	+18	294,057,000	+17	785,000	535,633,000	+17
1888-----	242,010,000	+5	310,889,000	+6	900,000	553,799,000	+3
1889-----	250,325,000	+3	291,004,000	-6	997,000	542,326,000	-2
1890-----	303,440,000	+21	310,995,000	+7	994,000	615,429,000	+13
1891-----	280,485,000	-8	319,364,000	+3	1,000,000	600,849,000	-2
1892-----	283,715,000	+1	337,517,000	+6	1,000,000	622,232,000	+4
1893-----	223,154,000	-21	321,339,000	-5	1,000,000	545,493,000	-12
1894-----	186,835,000	-16	362,410,000	+13	1,000,000	550,245,000	+9
1895-----	248,033,000	+33	393,658,000	+9	1,000,000	642,691,000	+17
1896-----	252,075,000	+2	387,966,000	-1	1,000,000	641,041,000	-3
1897-----	269,934,000	+7	380,678,000	-2	1,000,000	651,612,000	+2
1898-----	308,247,000	+14	417,795,000	+10	1,000,000	727,042,000	+12
1899-----	483,521,000	+57	525,575,000	+26	1,000,000	1,010,096,000	+39
1900-----	513,732,000	+6	594,204,000	+13	1,000,000	1,108,936,000	+10
1901-----	493,314,000	-4	660,764,000	+11	1,000,000	1,155,078,000	+4
1902-----	604,517,000	+23	722,434,000	+9	1,000,000	1,327,951,000	+15
1903-----	588,753,000	-3	905,628,000	+25	1,000,000	1,495,381,000	+13
1904-----	501,114,000	-15	857,667,000	-5	400,000	1,359,181,000	-9
1905-----	702,585,000	+40	920,780,000	+7	400,000	1,623,765,000	+19
1906-----	886,180,000	+26	1,014,500,000	+10	200,000	1,900,880,000	+17
1907-----	904,108,000	+2	1,165,376,000	+15	86,000	2,069,570,000	+9
1908-----	550,768,000	-39	1,040,761,000	-11	244,000	1,591,773,000	-23
1909-----	754,944,000	+37	1,131,866,000	+9	297,000	1,887,107,000	+19
1910-----	749,879,000	-7	1,237,668,000	+9	297,000	1,987,844,000	+5
1911-----	680,907,000	-9	1,242,942,000	+4	232,000	1,924,081,000	-3
1912-----	862,008,000	+27	1,375,420,000	+11	366,000	2,237,794,000	+16
1913-----	878,869,000	+2	1,554,298,000	+13	378,000	2,433,545,000	+9
1914-----	686,639,000	-22	1,424,063,000	-8	470,000	2,111,172,000	-13
1915-----	991,730,000	+44	1,400,484,000	-2	2,430,000	2,394,644,000	+13
1916-----	1,620,745,000	+63	1,884,413,000	+35	3,281,000	3,508,439,000	+47
1917-----	2,086,234,000	+29	2,900,462,000	+54	5,800,000	4,992,496,000	+42
1918-----	2,153,318,000	+3	3,380,690,000	+17	6,700,000	5,540,708,000	+11
1919-----	1,359,744,000	-37	3,232,626,000	-4	3,400,000	4,595,770,000	-17
1920-----	1,762,350,000	+30	5,214,170,000	+61	4,820,000	6,981,340,000	+52
1921-----	654,130,000	-63	3,481,720,000	-33	2,650,000	4,138,500,000	-41
1922-----	987,180,000	+51	3,656,410,000	+5	3,700,000	4,647,290,000	+12
1923-----	1,510,930,000	+53	4,471,620,000	+22	3,950,000	5,986,500,000	+29
1924-----	1,232,330,000	-18	4,067,730,000	-9	5,740,000	5,305,800,000	-11
1925-----	1,380,280,000	+12	4,291,100,000	+5	6,250,000	5,677,630,000	+7
1926-----	1,402,920,000	+2	4,803,080,000	+12	7,600,000	6,213,600,000	+9
1927-----	1,217,700,000	-13	4,304,100,000	-10	8,200,000	5,530,000,000	-11
1928-----	1,284,580,000	+5	4,091,120,000	-5	8,700,000	5,384,400,000	-3
Grand total.	34,922,950,000	-----	73,251,682,000	-----	129,557,000	108,304,189,000	-----

Mineral products of the United States and principal producing States in 1928

Rank in value	Product	Principal producing States ¹	
		In order of quantity	In order of value
16	Aluminum.....	Not separable by States.....	New York, North Carolina, Tennessee.
34	Antimonial lead.....	Alaska, Nevada, California.....	Not separable by States.
86	Antimony ore.....	Montana, Utah, Colorado.....	Rank same as for quantity.
57	Arsenious oxide.....	Georgia, Arizona, Maryland, Alabama.....	Do.
60	Asbestos.....	Texas, Kentucky, Oklahoma, Utah.....	Arizona, Georgia, Maryland, Alabama.
	Asphalt:		
31	Native.....	Not separable by States.....	Kentucky, Utah, Texas, Oklahoma.
24	Oil.....	Missouri, Georgia, Tennessee, California.....	Not separable by States.
45	Barite (crude).....	Arkansas, Georgia, Alabama, Tennessee.....	Rank same as for quantity.
41	Bauxite.....	Not separable by States.....	Arkansas, Alabama, Georgia, Tennessee.
55	Bismuth.....	California, Nevada.....	Not separable by States.
33	Borates.....	Wisconsin, Pennsylvania, Washington, Oregon.....	Rank same as for quantity.
29	Briquets, fuel.....	Michigan, California, Ohio, West Virginia.....	Wisconsin, Pennsylvania, Oregon, Washington.
58	Bromine.....	Not separable by State.....	Rank same as for quantity.
49	Cadmium (metal and compounds).....	Michigan, California, Ohio, Oklahoma.....	Not separable by States.
43	Calcium-magnesium chloride (natural).....	Pennsylvania, Michigan, Indiana, California.....	Rank same as for quantity.
6	Cement.....	Missouri, Oklahoma, Kansas.....	Pennsylvania, California, Indiana, Michigan.
62	Chabazite.....	California, Maryland.....	Rank same as for quantity.
83	Chromite.....	Pennsylvania, Missouri, California, Ohio.....	Do.
4	Clay products.....		Ohio, Pennsylvania, New Jersey, Illinois.
25	Clay, raw.....		Pennsylvania, Georgia, Missouri, New Jersey.
1	Coal:		
	Bituminous.....	West Virginia, Pennsylvania, Kentucky, Illinois.....	Pennsylvania, West Virginia, Illinois, Kentucky.
	Pennsylvania anthracite.....	Pennsylvania.....	Rank same as for quantity.
8	Coke.....	Pennsylvania, Ohio, Indiana, Alabama.....	Pennsylvania, Indiana, Ohio, New York.
80	Columbite.....	South Dakota.....	Rank same as for quantity.
7	Copper.....	Arizona, Utah, Montana, Michigan.....	Do.
46	Diatomite and tripoli.....	California, Oklahoma, Illinois, Missouri.....	Do.
82	Emery.....	New York, Virginia.....	Virginia, New York.
48	Feldspar (crude).....	North Carolina, New Hampshire, Maine, New York.....	Rank same as for quantity.
15	Ferro-alloys.....	Pennsylvania, New York, Ohio, Alabama.....	Do.
76	Flint lining for tube mills.....	Minnesota.....	Do.
40	Fluorspar.....	Kentucky, Illinois, New Mexico, Colorado.....	Do.
35	Fuller's earth.....	Georgia, Florida, Nevada, Texas.....	Do.
83	Garnet, abrasive.....	New York, New Hampshire.....	Do.
(1)	Gems and precious stones.....	No canvass for 1928.....	No canvass for 1928.
17	Gold.....	California, Alaska, South Dakota, Colorado.....	Rank same as for quantity.
67	Graphite:		
	Amorphous.....	Rhoda Island, Michigan, Nevada.....	Texas, Alabama, Rhoda Island, Michigan.
	Crystalline.....	Texas, Alabama, New Jersey, Georgia.....	Rank same as for quantity.
47	Grindstones and pulpstones.....	Ohio, West Virginia, Washington.....	Do.
21	Gypsum.....	New York, Iowa, Michigan, Texas.....	Do.
10	Iron ore.....	Minnesota, Michigan, Alabama, Wisconsin.....	New York, Iowa, Ohio, Michigan.
3	Iron, pig.....	Pennsylvania, Ohio, Illinois, Indiana.....	Rank same as for quantity.
13	Lead.....	Missouri, Utah, Idaho, Oklahoma.....	Do.
19	Lime.....	Ohio, Pennsylvania, Missouri, West Virginia.....	Do.
74	Lithium minerals.....	New Mexico, South Dakota.....	Ohio, Pennsylvania, Missouri, Massachusetts.
52	Magnesite.....	Washington, California.....	Rank same as for quantity.
61	Magnesium.....	Michigan.....	Do.
53	Magnesium salts (natural).....	Michigan, California.....	Do.
50	Manganese ore.....	Montana, Georgia, Virginia, Arkansas.....	Do.
38	Manganiferous ore.....	Minnesota, New Mexico, Michigan, Colorado.....	Do.
65	Manganiferous zinc residuum.....	New Jersey.....	Do.
	Marl:		
73	Calcareous.....	Virginia, California, West Virginia, South Carolina.....	Do.
72	Oreosand.....	New Jersey, Texas.....	Do.
42	Mercury.....	California, Oregon, Nevada, Texas.....	Do.
64	Mica.....	North Carolina, New Hampshire, New Mexico, South Dakota.....	North Carolina, New Hampshire, New Mexico, Connecticut.
	Scrap.....	North Carolina, New Mexico, New Hampshire, South Dakota.....	North Carolina, New Hampshire, New Mexico, South Dakota.
	Sheet.....	North Carolina, New Hampshire, Connecticut, Maine.....	Rank same as for quantity.
75	Micaceous minerals.....	North Carolina, Montana, Georgia, Colorado.....	Montana, North Carolina, Georgia, Colorado.
78	Millstones.....	Pennsylvania, Ohio, Indiana, Illinois.....	New York, North Carolina, Virginia, New Hampshire.
23	Mineral paints, zinc and lead pigments.....	No canvass for 1928.....	Rank same as for quantity.
(1)	Mineral waters.....	Colorado, New Mexico, Arizona.....	No canvass for 1928.
44	Molybdenum.....	Oklahoma, Texas, California, Louisiana.....	Rank same as for quantity.
5	Natural gas.....	Oklahoma, California, Texas, West Virginia.....	West Virginia, California, Texas, Pennsylvania.
11	Natural gasoline.....	Not separable by States.....	California, Oklahoma, Texas, West Virginia.
68	Nickel.....	Ohio, Arkansas, Indiana, Vermont.....	Not separable by States.
70	Oilstones, etc.....	No canvass for 1928.....	Arkansas, Ohio, Vermont, Indiana.
(1)	Peat.....	California, Minnesota.....	No canvass for 1928.
85	Pebbles for grinding.....	Texas, Oklahoma, California, Kansas.....	Minnesota, California.
2	Petroleum.....	Florida, Tennessee, Idaho, Wyoming.....	Oklahoma, Texas, California, Kansas.
26	Phosphate rock.....	California, Oregon, Alaska.....	Rank same as for quantity.
32	Platinum and allied metals.....	California, Maryland, Indiana, Pennsylvania.....	Do.
39	Potassium salts.....	Kansas, Nebraska, California, Arizona.....	Do.
69	Pumice.....	Virginia, California.....	Do.
60	Pyrites.....	Michigan, New York, Ohio, Kansas.....	California, Virginia.
22	Salt.....	New York, Illinois, California, Michigan.....	Michigan, New York, Kansas, Ohio.
12	Sand and gravel.....	Michigan, Massachusetts, New York, New Jersey.....	New York, Pennsylvania, Illinois, Ohio.
36	Sand-lime brick.....	Not separable by States.....	Michigan, New York, Massachusetts, New Jersey.
19	Selenium.....	California, North Carolina, Maryland, Wisconsin.....	Not separable by States.
71	Silica (quartz).....	West Virginia, Illinois, New Jersey, Pennsylvania.....	Wisconsin, California, North Carolina, Nevada.
51	Silica sand and sandstone (finely ground).....	Utah, Montana, Idaho, Arizona.....	West Virginia, Pennsylvania, Illinois, New Jersey.
20	Silver.....		Rank same as for quantity.
27	Slate.....	California, Arizona, Wyoming, Nevada.....	Pennsylvania, Vermont, New York, Virginia.
30	Sodium salts (other than NaCl) from natural sources.....	Pennsylvania, Ohio, Michigan, New York.....	Rank same as for quantity.
0	Stone.....	Texas, Louisiana, Nevada, Utah.....	Indiana, Pennsylvania, New York, Ohio.
18	Sulphur.....	Tennessee, Illinois, Pennsylvania, Arizona.....	Rank same as for quantity.
28	Sulphuric acid from copper and zinc smelters.....	New York, Vermont, Virginia, California.....	Tennessee, Illinois, Pennsylvania, Ohio.
37	Talc and soapstone.....	Not separable by States.....	
87	Tellurium.....	Alaska, California, South Dakota.....	New York, Virginia, Vermont, California.
77	Tin.....		Not separable by States.
	Titanium ore:		Rank same as for quantity.
81	Ilmenite.....	Virginia, Florida.....	Do.
79	Rutile.....	do.....	Do.
56	Tungsten ore.....	Nevada, California, Colorado, South Dakota.....	Do.
54	Uranium and vanadium ores.....	Colorado, Nevada, Utah.....	Colorado, Utah, Nevada.
14	Zinc.....	Oklahoma, Kansas, New Jersey, Montana.....	Oklahoma, New Jersey, Kansas, Montana.
54	Zircon.....	Florida.....	Rank same as for quantity.

¹ Rank of States in metal production (except aluminum, ferro-alloys, and pig iron) arranged according to mine reports, not smelter output.

² No canvass for 1928.

Value of mineral products of the United States, 1924-1928, by States¹

State	1924	1925	1926	1927	1928
Alabama.....	\$77,315,758	\$77,139,340	\$83,709,894	\$78,640,669	\$69,807,334
Alaska.....	17,361,834	18,286,320	17,066,890	14,402,440	14,024,489
Arizona.....	100,327,062	114,202,670	115,047,987	100,558,556	115,999,643
Arkansas.....	61,748,999	87,185,532	84,485,672	59,449,100	45,009,780
California.....	428,175,652	496,923,376	524,282,257	459,497,072	434,261,175
Colorado.....	61,487,882	63,512,998	65,597,487	58,855,263	58,594,688
Connecticut.....	8,129,332	6,755,454	7,695,341	7,299,100	7,599,655
Delaware.....	512,105	539,261	375,945	493,377	481,584
District of Columbia.....	813,608	954,795	987,289	1,374,719	1,031,216
Florida.....	13,120,295	16,625,699	19,700,522	18,095,961	15,227,123
Georgia.....	14,946,610	16,503,741	17,479,967	16,758,390	14,740,431
Idaho.....	27,831,623	31,611,166	31,752,821	29,183,929	28,589,221
Illinois.....	235,796,027	231,658,604	237,241,600	180,393,779	188,098,866
Indiana.....	112,299,075	111,833,732	118,692,304	107,578,234	98,583,915
Iowa.....	40,459,869	38,420,203	35,971,787	33,426,375	35,498,669
Kansas.....	105,005,476	142,944,214	165,060,612	120,368,526	113,279,524
Kentucky.....	120,510,775	131,370,840	146,768,273	152,614,177	131,969,907
Louisiana.....	56,930,681	60,503,891	62,203,543	51,266,921	56,810,403
Maine.....	6,035,160	5,838,718	5,785,619	5,475,695	5,922,729
Maryland.....	18,506,867	21,557,810	24,066,996	20,469,294	18,417,781
Massachusetts.....	15,725,882	16,831,529	16,786,577	16,295,373	16,234,037
Michigan.....	114,239,386	122,212,254	130,860,609	124,029,572	123,535,869
Minnesota.....	107,844,680	110,252,956	118,361,306	102,972,753	108,274,963
Mississippi.....	2,090,422	2,171,945	1,882,986	2,553,633	2,634,347
Missouri.....	81,054,122	92,548,473	90,003,537	75,890,415	74,981,382
Montana.....	70,631,806	79,261,284	79,766,380	68,264,687	74,752,309
Nebraska.....	3,209,425	3,358,585	3,322,460	3,541,792	3,454,700
Nevada.....	26,225,943	26,469,901	27,613,232	26,753,295	34,881,787
New Hampshire.....	3,378,165	3,464,837	4,144,645	3,447,105	3,816,065
New Jersey.....	75,271,009	76,761,313	77,065,713	73,090,810	70,865,363
New Mexico.....	23,913,528	25,696,009	28,513,991	28,608,776	30,426,840
New York.....	95,435,299	102,035,557	112,016,262	112,209,533	108,025,750
North Carolina.....	9,261,467	9,504,063	10,992,793	11,703,671	11,480,406
North Dakota.....	2,735,477	2,662,029	2,804,837	2,869,663	3,082,621
Ohio.....	249,049,648	247,506,588	253,883,995	226,962,529	211,041,279
Oklahoma.....	393,030,665	501,767,118	569,518,693	524,594,732	486,634,347
Oregon.....	7,364,232	7,826,711	6,941,355	6,821,224	6,686,988
Pennsylvania.....	1,011,630,879	867,196,142	1,055,766,077	936,773,189	881,490,033
Rhode Island.....	1,132,641	1,151,857	1,339,398	1,310,756	830,742
South Carolina.....	3,444,366	3,507,804	3,677,209	4,251,137	4,045,849
South Dakota.....	6,925,676	7,971,650	7,595,358	8,463,952	9,443,488
Tennessee.....	35,354,525	38,869,198	39,296,668	37,874,981	38,789,242
Texas.....	272,729,023	351,211,629	420,586,730	374,503,420	378,616,955
Utah.....	84,356,626	100,275,442	98,985,218	90,388,455	97,381,148
Vermont.....	14,549,429	14,408,933	14,955,161	14,702,891	14,648,737
Virginia.....	37,962,143	41,038,393	46,136,458	41,322,998	38,770,281
Washington.....	21,159,370	22,382,132	21,256,952	21,965,917	22,119,541
West Virginia.....	307,314,205	333,527,697	395,941,940	366,643,205	336,636,948
Wisconsin.....	15,796,720	19,205,380	20,711,736	21,776,847	20,889,395
Wyoming.....	75,494,166	78,754,915	78,988,066	56,166,600	52,950,875

¹ In this table iron ore, not pig iron, is taken as the basis of valuation of iron, and in the case of other metals mine production (recoverable content of metals) is the basis.

*States and their principal mineral products in 1928*¹

State	Rank	Percent- age of total value for United States	Principal mineral products in order of value
Alabama	19	1.48	Coal, iron ore, cement, clay products.
Alaska	37	.30	Gold, copper, coal, silver.
Arizona	10	2.46	Copper, silver, gold, lead.
Arkansas	23	.95	Petroleum, coal, natural gas, natural gasoline.
California	3	9.20	Petroleum, natural gas, natural gasoline, cement.
Colorado	20	1.24	Coal, gold, zinc, lead.
Connecticut	40	.16	Stone, clay products, lime, sand and gravel.
Delaware	50	.01	Clay products, stone, sand and gravel.
District of Columbia	48	.02	Sand and gravel, clay products, sand-lime brick, stone.
Florida	34	.32	Phosphate rock, stone, fuller's earth, cement.
Georgia	35	.31	Stone, clay products, cement, fuller's earth.
Idaho	29	.61	Lead, silver, zinc, stone.
Illinois	7	3.98	Coal, clay products, cement, sand and gravel.
Indiana	14	2.09	Coal, stone, cement, clay products.
Iowa	26	.75	Cement, coal, gypsum, clay products.
Kansas	11	2.40	Petroleum, natural gas, zinc, cement.
Kentucky	8	2.80	Coal, petroleum, clay products, natural gas.
Louisiana	21	1.20	Petroleum, natural gas, natural gasoline, salt.
Maine	42	.13	Stone, lime, cement, slate.
Maryland	32	.39	Coal, clay products, cement, sand and gravel.
Massachusetts	33	.34	Stone, sand and gravel, clay products, lime.
Michigan	9	2.62	Iron ore, copper, cement, salt.
Minnesota	12	2.29	Iron ore, stone, cement, manganese ore.
Mississippi	47	.06	Sand and gravel, clay products, stone, natural gas.
Missouri	16	1.59	Lead, clay products, cement, coal.
Montana	17	1.58	Copper, zinc, coal, petroleum.
Nebraska	45	.07	Sand and gravel, cement, clay products, stone.
Nevada	27	.74	Copper, gold, silver, gypsum.
New Hampshire	44	.08	Stone, sand and gravel, clay products, feldspar.
New Jersey	18	1.50	Clay products, zinc, cement, stone.
New Mexico	28	.64	Copper, coal, zinc, petroleum.
New York	13	2.29	Clay products, stone, cement, sand and gravel.
North Carolina	38	.24	Stone, clay products, copper, sand and gravel.
North Dakota	46	.07	Coal, clay products, sand and gravel, natural gas.
Ohio	6	4.47	Clay products, natural gas, coal, cement.
Oklahoma	2	10.31	Petroleum, natural gas, natural gasoline, zinc.
Oregon	41	.14	Stone, cement, sand and gravel, clay products.
Pennsylvania	1	18.67	Coal, cement, natural gas, clay products.
Rhode Island	49	.02	Stone, sand and gravel, lime, graphite.
South Carolina	43	.09	Stone, clay products, sand and gravel, barite.
South Dakota	39	.20	Gold, sand and gravel, cement, stone.
Tennessee	24	.82	Coal, stone, cement, clay products.
Texas	4	8.02	Petroleum, natural gas, sulphur, natural gasoline.
Utah	15	2.06	Copper, lead, coal, silver.
Vermont	36	.31	Stone, slate, talc, lime.
Virginia	25	.82	Coal, stone, clay products, cement.
Washington	30	.47	Coal, cement, sand and gravel, clay products.
West Virginia	5	7.13	Coal, natural gas, clay products, petroleum.
Wisconsin	31	.44	Stone, iron ore, sand and gravel, zinc.
Wyoming	22	1.12	Petroleum, coal, natural gas, natural gasoline.

¹ In this table iron ore, not pig iron, is taken as the basis of iron valuation, and in the case of other metals mine production (recoverable content of metals) is the basis.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver ¹	Cop- per ²	Lead ²	Zinc ²	Year	Silver ¹	Cop- per ²	Lead ²	Zinc ²
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919	\$1.12	\$0.186	\$0.053	\$0.073	1924	\$0.670	\$0.131	\$0.080	\$0.065
1920	1.09	.184	.080	.081	1925	.694	.142	.087	.076
1921	1.00	.129	.045	.050	1926	.624	.140	.080	.075
1922	1.00	.135	.055	.057	1927	.567	.131	.063	.064
1923	.82	.147	.070	.068	1928	.585	.144	.058	.061

¹ Average price furnished by Bureau of the Mint.

² Average price, all grades.

DETAILED TABLES ABRASIVE MATERIALS

*Natural abrasives sold by producers in the United States, 1919-1928*¹

Year	Millstones ²	Grindstones		Pulpstones ³		Oilstones and scythestones		Emery	
		Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	\$66,972	40,755	\$993,959	6,110	\$342,056	1,463	\$235,943	2,601	\$23,203
1920.....	63,325	44,832	1,239,990	8,652	467,014	1,144	231,747	2,327	21,685
1921.....	24,524	16,310	477,259	10,080	750,063	831	173,025	305	2,250
1922.....	20,853	21,367	574,900	5,157	445,286	1,016	197,450	1,468	17,511
1923.....	22,229	37,384	1,008,899	9,186	680,416	1,223	231,812	2,286	29,478
1924.....	30,125	28,991	852,260	9,193	814,409	1,056	258,943	2,195	19,756
1925.....	22,490	28,970	864,637	8,370	841,302	970	272,224	769	5,907
1926.....	45,937	28,669	875,240	9,670	997,994	1,680	223,359	386	3,641
1927.....	35,438	23,222	633,207	8,709	921,543	1,018	233,545	506	5,855
1928.....	42,886	24,222	606,408	9,016	902,429	956	228,245	1,341	16,787

Year	Garnet		Diatomite		Tripoli (including rottenstone)			Pumice		Grinding pebbles and tube-mill lining	
	Short tons	Value	Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
						Crude (estimated)	As sold (crude and finished)				
1919...	4,944	\$310,131	42,642	\$531,960	24,292	\$98,010	\$181,541	36,051	\$116,835	9,448	\$85,302
1920...	5,476	434,425	61,922	1,079,693	40,233	164,076	569,677	41,838	114,433	10,924	77,823
1921...	3,048	260,687	55,134	682,616	12,340	53,892	213,013	37,108	158,540	989	14,637
1922...	7,054	566,879	44,761	386,669	30,205	105,309	316,728	45,262	175,600	3,159	30,798
1923...	9,006	688,437	65,833	699,406	27,082	62,190	382,757	56,575	214,169	4,551	51,795
1924...	8,290	674,176	63,163	693,917	28,476	55,537	389,400	43,651	190,253	2,532	37,429
1925...	8,429	712,853	73,030	922,281	29,388	58,770	434,886	40,380	179,020	3,831	50,147
1926...	6,397	523,875	87,126	1,081,564	31,369	65,022	523,609	53,887	208,504	6,219	85,146
1927...	6,939	573,525	(9)	(9)	26,099	66,452	447,068	53,298	221,481	3,342	46,856
1928...	6,617	459,307	(9)	(9)	34,043	73,689	555,576	57,430	278,516	6,288	89,321

¹ For figures on abrasive feldspar and quartz, see sections on feldspar and silica.

² Figures for quantity not available.

³ Exclusive of sales in Washington prior to 1923.

⁴ Partly estimated.

⁵ Bureau of Mines not at liberty to publish figures.

Value of abrasive materials imported for consumption in the United States, 1919-1928

Material	1919	1920	1921	1922	1923
Millstones and burrstones.....	\$26,356	\$20,954	\$13,556	\$15,356	\$20,102
Grindstones.....	50,551	77,046	81,880	81,733	106,028
Hones, oilstones, and whetstones.....	12,199	56,416	35,761	48,938	53,233
Emery and corundum.....	595,203	617,187	393,454	389,390	722,688
Garnet.....	(1)	(1)	(1)	¹ 1,837	93,803
Diatomaceous earth, tripoli, and rottenstone.....	12,545	16,323	13,203	10,429	11,779
Pumice.....	119,781	249,995	173,201	118,458	128,693
Diamond dust and bort.....	1,420,442	3,387,488	466,345	1,029,261	228,409
Flint, flints, and flint stones, unground.....	250,096	338,630	116,157	145,805	130,974
Material	1924	1925	1926	1927	1928
Millstones and burrstones.....	\$6,311	\$8,413	\$6,266	\$12,726	\$6,354
Grindstones.....	122,440	124,319	120,335	134,804	114,874
Hones, oilstones, and whetstones.....	43,579	49,108	63,152	67,368	45,303
Emery and corundum.....	364,755	313,718	616,700	264,613	272,533
Garnet.....	54,402	200			115
Diatomaceous earth, tripoli, and rottenstone.....	9,504	6,589	14,544	15,403	21,883
Pumice.....	111,284	130,460	129,449	124,074	159,430
Diamond dust and bort.....	259,482	760,476	271,382	62,045	31,222
Flint, flints, and flint stones, unground.....	114,958	105,041	120,078	93,658	144,313

¹ Not separately classified prior to change in tariff, Sept. 22, 1922.

Value of domestic abrasive materials exported, 1919-1928

Material	1919	1920	1921	1922	1923
Grindstones.....	\$297, 068	\$424, 322	\$281, 976	\$281, 413	\$499, 123
Abrasive wheels, emery, and other.....	3, 032, 067	2, 791, 128	1, 318, 804	644, 151	571, 733
All other natural abrasives, hones, whetstones, etc.....	2, 809, 231	3, 810, 171	1, 719, 810	292, 051	342, 737

Material	1924	1925	1926	1927	1928
Grindstones.....	\$481, 397	\$553, 750	\$629, 748	\$578, 113	\$560, 975
Abrasive wheels, emery, and other.....	521, 840	439, 904	248, 631	240, 027	254, 493
All other natural abrasives, hones, whetstones, etc.....	173, 731	195, 915	323, 447	419, 088	453, 055

ALUMINUM

[See Bauxite and aluminum]

ANTIMONY AND ANTIMONIAL LEAD*Mine production of antimony ores in the United States, 1919-1928, in short tons*

Year	Ore	Antimony content	Year	Ore	Antimony content
1919-1921.....			1925.....	123	33
1922.....	20	4	1926.....	99	43
1923.....	40	10	1927.....		
1924.....	113	33	1928.....	86	42

Only two smelters reported production of metallic antimony in the United States in 1919, 1926, and 1927 and only one in 1920, 1925, and 1928; the Bureau of Mines is not at liberty to publish the figures. No production was reported during the period 1921 to 1924. The total output in 1928 and part of that in 1926 came from domestic ore smelted.

Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1919-1928

Year	Short tons	Value ¹	Year	Short tons	Value ¹
1919.....	4, 399	\$717, 900	1924.....	9, 404	\$2, 025, 600
1920.....	5, 600	938, 560	1925.....	10, 840	3, 794, 000
1921.....	4, 720	464, 400	1926.....	16, 230	5, 164, 400
1922.....	7, 090	765, 700	1927.....	12, 400	3, 060, 300
1923.....	8, 021	1, 252, 800	1928.....	11, 900	2, 451, 400

¹ Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1919-1928

Year	Short tons	Value	Antimony content (short tons)	Year	Short tons	Value	Antimony content (short tons)
1919-----	13, 874	\$1, 513, 968	1, 943	1924-----	20, 787	\$3, 376, 713	2, 763
1920-----	12, 535	1, 953, 255	2, 033	1925-----	19, 667	3, 785, 547	2, 624
1921-----	10, 064	870, 059	1, 589	1926-----	22, 524	3, 916, 714	2, 693
1922-----	8, 075	844, 993	1, 441	1927-----	24, 347	3, 277, 043	2, 736
1923-----	14, 190	1, 950, 370	2, 170	1928-----	33, 058	3, 978, 318	3, 432

Antimony imported for consumption in the United States, 1919-1928

Year	Antimony ore ¹			Liquated antimony sulphide ²		Metallic antimony ³		Antimony oxides and other compounds ⁴	
	Short tons	Antimony content		Short tons	Value	Short tons	Value	Short tons	Value
		Short tons	Value						
1919-----	993	409	\$54, 477	278	\$19, 202	7, 159	\$1, 021, 587	126	\$9, 501
1920-----	1, 709	682	70, 285	1, 375	123, 902	9, 817	1, 216, 376	298	25, 260
1921-----	213	98	11, 682	353	17, 577	10, 130	784, 146	154	15, 558
1922-----	(9)			689	40, 108	9, 344	659, 242	379	65, 538
1923-----	(9)	1, 047	44, 721	835	64, 493	6, 763	641, 804	2, 277	288, 206
1924-----	(9)	899	62, 999	558	52, 393	6, 778	840, 434	1, 207	190, 252
1925-----	1, 359	773	47, 084	760	115, 990	9, 857	2, 362, 915	1, 792	349, 990
1926-----	2, 497	1, 559	287, 258	2, 040	343, 705	11, 506	3, 144, 330	2, 259	517, 584
1927-----	3, 566	2, 015	282, 098	1, 077	134, 949	9, 891	2, 111, 411	1, 803	484, 873
1928-----	3, 912	2, 185	313, 127	1, 208	158, 231	9, 684	1, 641, 265	2, 643	448, 156

¹ Classified in tariff classification as "Antimony ore and stibnite containing antimony."

² Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead"; also as "needle or liquated antimony."

³ Classified in tariff classification as "Antimony regulus or metal."

⁴ Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

⁵ Figures not available.

Foreign antimony (matte, regulus, or metal) exported from the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919 ¹ -----	429, 059	\$33, 913	1924-----	279, 920	\$14, 441
1920-----	896, 034	51, 607	1925-----	188, 976	17, 376
1921-----	299, 776	15, 741	1926-----	367, 942	41, 554
1922 ² -----	37, 218	1, 548	1927-----	726, 694	72, 280
1923-----	15, 958	1, 047	1928-----	1, 198, 339	90, 975

¹ Also 3 short tons of antimony ore, containing 5,380 pounds of antimony, valued at \$1,665, was exported in 1919.

² During 1922 exports of "matte, regulus, or metal" of domestic manufacture were 224,610 pounds, valued at \$13,961. This is the first export of domestic antimony of which there is any record. However, antimony manufactured in the United States from foreign ores and exported would be classed as domestic exports. Similar exports for 1923 to 1928 are not shown.

ARSENIC

White arsenic (refined and crude) sold by producers in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	1 6, 029	1 \$1, 181, 684	1924.....	14, 453	\$2, 655, 015
1920.....	11, 502	2, 021, 356	1925.....	12, 317	1, 199, 247
1921.....	4, 786	717, 700	1926.....	11, 805	674, 350
1922.....	10, 027	1, 475, 229	1927.....	11, 560	725, 360
1923.....	14, 271	2, 808, 801	1928.....	11, 767	735, 373

¹ In addition to the arsenious oxide (or white arsenic) elemental arsenic was produced from ore in 1919. The totals shown include this elemental arsenic.

Arsenic compounds and metallic arsenic imported for consumption in the United States, 1919-1928

Year	Arsenious acid (white arsenic, As ₂ O ₃)		Arsenic sulphide (realgar and orpiment)		Sheep dip		Paris green and London purple	
	Short tons	Value	Short tons	Value	Pounds	Value	Pounds	Value
1919.....	4, 389	\$624, 494	2, 151	\$316, 687	146, 803	\$12, 346	18	\$14
1920.....	3, 740	532, 635	4, 080	684, 016	70, 168	5, 150	772	277
1921.....	1, 669	253, 250	3, 343	531, 322	61, 377	6, 362	325	123
1922.....	1, 081	162, 494	3, 815	472, 044	70, 390	4, 877	3, 866	741
1923.....	10, 152	1, 985, 400	1, 097	268, 311	87, 739	5, 237	100, 781	20, 586
1924.....	8, 877	1, 597, 433	234	45, 246	114, 801	10, 764	76, 241	15, 683
1925.....	9, 316	1, 076, 073	476	63, 296	73, 477	4, 953	2, 880	702
1926.....	7, 703	510, 227	283	40, 718	119, 947	14, 070	4, 747	1, 011
1927.....	12, 517	921, 998	206	35, 089	102, 394	8, 952	-----	-----
1928.....	11, 153	775, 169	263	51, 278	175, 055	17, 592	13, 279	1, 497

Year	Arsenic acid (H ₃ AsO ₄)		Calcium arsenate		Lead arsenate		Metallic arsenic	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919-1921.....	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1922 ²	41, 296	\$4, 195	-----	-----	-----	-----	22, 487	\$3, 484
1923.....	166, 354	15, 597	-----	-----	26	\$9	174, 415	37, 314
1924.....	420	121	3, 172	\$278	3, 585	525	122, 467	23, 684
1925.....	59, 112	2, 676	1, 074	135	10, 467	1, 514	149, 018	31, 918
1926.....	2, 340	165	1, 057	284	-----	-----	174, 490	35, 745
1927.....	11, 685	470	3, 807	717	-----	-----	245, 686	47, 875
1928.....	75	30	1, 323	233	-----	-----	186, 622	35, 584

¹ Figures not available.

² Figures cover period Sept. 22 to Dec. 31. Not separately classified prior to change in tariff.

Exports of domestic arsenic were not separately recorded by the Bureau of Foreign and Domestic Commerce prior to 1928, when they were as follows: Calcium arsenate, 1,178,702 pounds, valued at \$67,151; lead arsenate, 1,093,673 pounds, \$141,235.

Foreign arsenic and sulphide of, or orpiment, exported from the United States, 1919-1922 ¹

Year	Pounds	Value	Year	Pounds	Value
1919.....	-----	-----	1921.....	23, 765	\$2, 835
1920.....	13, 799	\$1, 827	1922.....	14, 290	1, 555

¹ Foreign exports not separately recorded after 1922.

ASBESTOS

Asbestos sold by producers in the United States, 1919-1928, by varieties

Year	Chrysotile		Amphibole		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	502	\$229,265	659	\$19,000	1,161	\$248,265
1920.....	1,245	661,907	403	16,324	1,648	678,231
1921.....	438	313,268	393	23,700	831	336,968
1922.....	25	3,320	42	6,800	67	10,120
1923.....	69	4,433	158	5,193	227	9,626
1924.....	173	33,941	127	8,585	300	42,526
1925.....	93	40,750	1,165	10,950	1,258	51,700
1926.....	(1)	(1)	(1)	(1)	1,358	134,731
1927.....	(1)	(1)	(1)	(1)	2,981	336,882
1928.....	(1)	(1)	(1)	(1)	2,239	351,178

¹ Bureau of Mines not at liberty to publish figures.

Asbestos (unmanufactured) imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Short tons	Value	Short tons	Value
1919.....	135,270	\$7,369,685	1,119	\$157,416
1920.....	167,558	9,120,253	615	141,071
1921.....	72,463	2,948,302	520	101,600
1922.....	149,427	5,144,700	376	49,939
1923.....	212,420	7,445,143	680	48,525
1924.....	183,250	5,602,945	1,270	93,163
1925.....	230,520	7,134,302	1,109	70,846
1926.....	257,621	8,142,505	1,104	85,922
1927.....	223,653	8,150,340	309	48,774
1928.....	230,595	9,017,891	850	346,632

ASPHALT AND RELATED BITUMENS

Native asphalt and related bitumens sold at mines in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	88,281	\$682,989	1924.....	562,367	\$3,958,339
1920.....	198,497	1,213,908	1925.....	584,850	4,148,400
1921.....	296,412	1,985,583	1926.....	715,180	4,484,960
1922.....	327,792	2,253,180	1927.....	839,040	5,605,850
1923.....	400,236	2,885,631	1928.....	807,860	5,175,055

Asphalt, manufactured in the United States from petroleum, sold at refineries in 1919-1928

Year	From domestic petroleum		From foreign petroleum	
	Short tons	Value	Short tons	Value
1919.....	614,692	\$8,727,372	674,876	\$7,711,510
1920.....	700,496	11,985,457	1,045,779	14,272,862
1921.....	624,220	9,048,221	908,093	11,761,358
1922.....	805,145	10,385,925	1,242,163	13,899,407
1923.....	995,654	13,060,174	1,378,722	16,840,045
1924.....	1,158,456	14,305,007	1,920,915	21,710,793
1925.....	1,206,700	15,305,760	1,971,670	27,520,010
1926.....	1,245,160	15,452,940	2,213,310	31,098,460
1927.....	1,525,420	19,019,150	2,426,030	35,771,940
1928.....	1,741,392	20,425,371	2,264,137	29,687,614

Asphalt and related bitumens imported for consumption in the United States, 1919-1928

Year	Crude asphalt		Ozokerite	
	Short tons	Value	Short tons	Value
1919.....	104, 913	\$609, 923	1, 874	\$454, 840
1920.....	127, 027	1, 055, 951	2, 136	499, 758
1921.....	116, 450	972, 166	4, 274	546, 054
1922.....	120, 359	940, 873	4, 495	371, 161
1923.....	138, 430	1, 046, 603	2, 428	213, 407
1924.....	156, 662	1, 165, 253	1, 557	207, 833
1925.....	113, 384	823, 165	3, 088	361, 767
1926.....	140, 746	1, 025, 629	4, 144	479, 957
1927.....	157, 982	1, 138, 898	3, 800	579, 118
1928.....	119, 560	864, 607	5, 451	594, 416

Year	Ichthyol		Bituminous limestone		Total	
	Pounds	Value	Short tons	Value	Short tons	Value
1919.....	30, 976	\$38, 975	735	\$5, 576	107, 537	\$1, 109, 314
1920.....	98, 135	79, 133	1, 387	11, 665	130, 599	1, 646, 507
1921.....	76, 020	107, 752	12, 085	157, 124	132, 847	1, 783, 096
1922.....	74, 330	89, 150	4, 300	59, 590	129, 191	1, 460, 774
1923.....	¹ 20	15	6, 205	33, 303	147, 063	1, 293, 328
1924.....	9, 300	17, 058	3, 354	37, 906	161, 578	1, 428, 050
1925.....	560	1, 281	8, 778	84, 259	125, 250	1, 270, 472
1926.....	25, 396	34, 385	1, 886	19, 967	146, 789	1, 559, 938
1927.....	48, 199	58, 821	118	1, 500	161, 924	1, 778, 337
1928.....	42, 610	60, 321	28	439	125, 060	1, 519, 783

¹ As recorded by Bureau of Foreign and Domestic Commerce. Reclassification after change in tariff, Sept. 22, 1922, may account to some extent for great decrease.

Native asphalt and related bitumens exported from the United States, 1919-1928

Year	Unmanufactured		Manufactures of (value)	Total value
	Short tons	Value		
1919.....	40, 208	\$1, 103, 930	\$606, 918	\$1, 710, 848
1920.....	51, 706	1, 356, 116	842, 074	2, 198, 190
1921.....	45, 367	1, 178, 038	621, 224	1, 799, 262
1922.....	57, 362	1, 344, 440	¹ 1, 261, 125	2, 605, 565
1923.....	72, 628	1, 500, 869	¹ 2, 075, 628	3, 576, 497
1924.....	52, 568	1, 245, 670	¹ 2, 212, 260	3, 457, 930
1925.....	32, 835	825, 654	¹ 2, 525, 618	3, 351, 272
1926.....	38, 218	905, 743	¹ 2, 189, 808	3, 095, 551
1927.....	39, 875	1, 034, 334	¹ 2, 399, 700	3, 434, 034
1928.....	26, 263	683, 563	¹ 2, 022, 251	2, 705, 814

¹ Includes value of squares (10 by 10 feet) of roofing asphalt as follows: 1922, 588,636 squares, \$870,200; 1923, 783,028 squares, \$1,124,491; 1924, 697,293 squares, \$908,469; 1925, 661,662 squares, \$919,977; 1926, 938,176 squares, \$1,212,409; 1927, 853,842 squares, \$1,150,722; 1928, 934,908 squares, \$1,251,429. Corresponding exports not separately shown prior to 1922.

Exports of petroleum asphalt were not separately recorded until 1925, when 89,014 short tons, valued at \$1,762,048, was exported. Similar exports in 1926 were 146,589 tons, valued at \$3,183,746; in 1927, 385,031 tons, valued at \$8,325,413; and in 1928, 492,362 tons, valued at \$9,788,501.

BARITE AND BARIUM PRODUCTS

BARITE

Crude barite sold or used by producers in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	209,330	\$1,727,822	1924.....	196,332	\$1,540,744
1920.....	228,113	2,142,464	1925.....	228,063	1,703,097
1921.....	66,369	531,958	1926.....	237,875	1,773,293
1922.....	155,040	1,123,950	1927.....	254,265	1,670,878
1923.....	214,183	1,664,156	1928.....	269,544	1,754,924

Crude barite sold or used by producers in the United States, 1927 and 1928, by States

State	1927		1928	
	Short tons	Value	Short tons	Value
California.....	13,919	\$71,708	12,557	\$51,502
Colorado.....			40	340
Georgia.....	94,039	580,300	112,316	675,509
Missouri.....	111,456	797,465	114,274	810,203
Nevada.....	884	3,969		
Tennessee.....	20,537	129,999	20,260	150,937
Other States ¹	13,430	87,437	10,097	66,433
	254,265	1,670,878	269,544	1,754,924

¹ South Carolina, Virginia, and Wisconsin.*Crude domestic and foreign barite used in the manufacture of barium products in the United States, 1919-1928, in short tons*

Year	In manufacture of—		
	Ground barite	Lithopone	Barium chemicals
1919.....	64,922	103,688	32,976
1920.....	79,052	113,181	37,210
1921.....	28,296	61,359	10,952
1922.....	48,280	94,259	25,303
1923.....	47,713	128,547	34,327
1924.....	42,855	137,127	33,181
1925.....	56,851	146,693	29,141
1926.....	69,048	178,889	33,119
1927.....	73,119	222,791	34,280
1928.....	74,814	211,592	48,289

Crude barite imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	118	\$594	1924.....	21,502	\$104,264
1920.....	24,874	146,858	1925.....	28,655	91,016
1921.....	11,054	59,371	1926.....	51,016	195,004
1922.....	23,239	104,680	1927.....	70,274	253,284
1923.....	15,045	93,721	1928.....	61,765	190,756

Exports of barite are not separately reported.

BARIUM PRODUCTS

Barium products, manufactured in the United States from either domestic or imported crude ore, sold in 1919-1928, in short tons¹

Product	1919 ²	1920	1921	1922	1923
Ground barite.....	57,985	65,748	27,661	46,176	39,605
Lithopone.....	79,643	89,373	55,016	83,360	98,199
Barium chemicals:					
Binoxide.....	(³)	(³)		(³)	
Carbonate.....	7,135	7,484	1,956	2,281	6,362
Chloride.....	4,509	3,084	(³)	2,022	3,301
Nitrate.....	(³)	(³)			
Sulphate (blanc fixe).....	5,227	8,046	2,471	7,349	6,761
Other ⁴	3,142	2,146	1,060	2,249	379
	157,641	175,881	88,164	143,437	154,607

Product	1924	1925	1926	1927	1928
Ground barite.....	38,296	49,674	57,812	57,658	64,425
Lithopone.....	109,469	145,019	159,931	176,994	200,468
Barium chemicals:					
Carbonate.....	6,058	4,962	5,394	5,969	7,626
Chloride.....	3,859	(³)	4,592	3,708	5,224
Sulphate (blanc fixe).....	7,796	11,748	(³)	13,395	(³)
Other ⁴	441	1,944	11,925	871	21,119
	165,919	213,347	239,654	258,595	298,862

¹ In order to avoid duplication of figures, barium chemicals manufactured from other barium chemicals bought in open market are not included in table.

² Figures for 1919 represent production.

³ Included under "Other."

⁴ Figures cover chemicals, as follows—1919: Binoxide, nitrate, and sulphide; 1920: Binoxide, hydroxide, nitrate, and sulphide; 1921 and 1925: Chloride, hydroxide, and sulphide; 1922: Binoxide, hydroxide, sulphide, and sulphhydrate; 1923-24: Hydroxide and sulphide; 1926: Hydroxide, sulphate, and sulphide; 1927: Binoxide, hydroxide, and sulphide; 1928: Binoxide, hydroxide, sulphate, and sulphide.

Barium products imported for consumption in the United States, 1919-1928

Product	1919	1920	1921	1922	1923
Manufactured barite.....		\$3,017	\$16,942	\$59,453	\$88,741
Lithopone.....	\$122,708	263,240	432,019	885,671	776,383
Barium carbonate:					
Natural (ground witherite).....	4,739	61,284	25,188	39,114	41,823
Manufactured (chemically precipitated).....	2,666	37,462	80,603	210,250	79,482
Barium binoxide.....		64,447	127,631	189,334	152,270
Barium chloride.....	19,846	151,778	72,621	112,785	75,014
Blanc fixe, or barium sulphate (chemically precipitated).....	90	8,485	22,470	76,445	32,063
Barium hydroxide.....	(¹)	(¹)	(¹)	¹ 6,573	16,872
Barium nitrate.....	(¹)	(¹)	(¹)	¹ 16,795	59,766
	150,049	589,713	777,474	1,596,420	1,322,414

Product	1924	1925	1926	1927	1928	
					Short tons	Value
Manufactured barite.....	\$38,292	\$40,008	\$44,781	\$38,568	3,098	\$33,378
Lithopone.....	543,025	478,395	661,700	656,166	9,885	808,200
Barium carbonate:						
Natural (ground witherite).....	56,415	63,634	80,679	65,821	4,311	82,434
Manufactured (chemically precipitated).....	128,217	160,164	189,167	119,014	5,222	116,241
Barium binoxide.....	120,374	70,553	8,157	1,264	6	1,310
Barium chloride.....	100,810	67,306	49,426	45,285	1,172	25,253
Blanc fixe, or barium sulphate (chemically precipitated).....	50,465	81,439	136,697	107,179	3,680	168,923
Barium hydroxide.....	8,241	5,605	9,789	12,439	186	10,031
Barium nitrate.....	54,638	58,192	49,494	65,284	789	69,010
	1,100,477	1,025,296	1,229,890	1,111,020	28,349	1,314,780

¹ Not separately classified prior to change in tariff, Sept. 22, 1922.

Prior to 1922 barium products had not been exported in appreciable quantity, and no separate record of the exports was kept. Exports of lithopone have been as follows: 1922, 1,616 short tons, valued at \$169,982; 1923, 1,485 tons, \$176,624; 1924, 923 tons, \$104,783; 1925, 1,287 tons, \$132,771; 1926, 1,941 tons, \$200,412; 1927, 2,110 tons, \$222,585; 1928, 3,326 tons, \$337,565.

BAUXITE AND ALUMINUM

BAUXITE

Bauxite produced in the United States, 1919-1928

Year	Georgia, Alabama, and Tennessee		Arkansas		Total	
	Long tons	Value	Long tons	Value	Long tons	Value
1919.....	43,076	\$346,588	333,490	\$1,855,159	376,566	\$2,201,747
1920.....	40,029	349,453	481,279	2,897,892	521,308	3,247,345
1921.....	14,700	134,400	124,850	755,400	139,550	889,800
1922.....	42,810	329,440	266,790	1,682,890	309,600	2,012,330
1923.....	28,810	176,030	493,880	2,980,580	522,690	3,156,610
1924.....	19,940	156,990	327,630	1,981,000	347,570	2,137,990
1925.....	20,220	109,800	296,320	1,878,450	316,540	1,983,250
1926.....	20,630	116,650	371,570	2,293,550	392,250	2,415,200
1927.....	17,110	95,920	303,830	1,892,860	320,940	1,988,780
1928.....	14,190	80,668	361,236	2,193,230	375,426	2,273,898

Bauxite imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports (including bauxite concentrates)	
	Long tons	Value	Long tons	Value
1919.....	6,082	\$36,820	17,701	\$1,372,094
1920.....	42,895	251,284	22,257	1,843,596
1921.....	27,587	164,589	5,942	488,785
1922.....	23,656	93,805	19,617	961,208
1923.....	119,020	593,882	78,560	3,380,486
1924.....	201,974	909,493	77,065	3,979,832
1925.....	353,696	1,549,120	78,633	4,134,455
1926.....	281,644	1,187,497	87,770	4,741,260
1927.....	356,580	1,572,236	121,858	7,800,491
1928.....	350,111	1,534,498	112,984	5,210,912

ALUMINUM

Value of aluminum produced in the United States, 1919-1928

Year	Primary metal	Secondary metal ¹	Year	Primary metal	Secondary metal ¹
1919.....	\$38,558,000	\$12,014,600	1924.....	\$37,607,000	\$14,596,200
1920.....	41,375,000	9,489,100	1925.....	36,430,000	24,816,000
1921.....	10,906,000	3,775,400	1926.....	37,583,000	23,868,000
1922.....	13,622,000	6,085,900	1927.....	39,266,000	23,469,600
1923.....	28,305,000	10,824,600	1928.....	47,899,000	22,848,400

¹ Value of secondary aluminum based on average price at New York, as given by American Metal Market.

Aluminum imported for consumption in the United States, 1919-1928

Year	Crude and semicrude ¹		Manufactures of ²	Total value
	Pounds	Value		
1919.....	13,852,065	\$4,530,579	\$38,016	\$4,568,595
1920.....	39,298,649	12,183,891	893,131	13,077,022
1921.....	32,539,017	7,627,508	1,262,283	8,889,791
1922.....	43,891,933	8,286,819	1,408,193	9,695,012
1923.....	42,476,789	8,316,816	425,747	8,742,563
1924.....	31,809,941	6,859,785	285,251	7,145,036
1925.....	41,997,178	9,805,645	301,122	10,106,767
1926.....	71,391,717	16,421,905	357,472	16,779,377
1927.....	62,575,222	13,316,986	884,992	14,201,978
1928.....	38,847,007	8,057,107	816,368	8,873,475

¹ Includes crude aluminum, plates, sheets, wire, etc.² Includes aluminum leaf, kitchen utensils, and all other manufactures of aluminum.*Aluminum and manufactures of aluminum exported from the United States, 1919-1928*

Year	Crude and semicrude ¹		Manufactures of	Total value
	Pounds	Value		
1919.....	5,020,352	\$1,744,896	\$2,145,430	\$3,890,326
1920.....	9,407,631	3,067,617	2,563,164	5,630,781
1921.....	2,196,378	801,075	2,307,782	3,108,857
1922.....	4,347,020	1,127,460	² 1,708,656	2,836,116
1923.....	5,539,671	1,517,562	² 2,053,977	3,571,539
1924.....	6,343,512	1,632,315	² 2,540,075	4,172,390
1925.....	12,642,034	3,365,815	² 2,691,256	6,057,071
1926.....	7,634,171	2,135,087	³ 2,317,216	4,452,303
1927.....	14,522,560	3,478,649	³ 2,828,772	6,307,421
1928.....	15,728,281	3,758,728	³ 3,132,762	6,891,490

¹ Includes ingots, metal and alloys, plates and sheets, etc.² Represents value of 4,544,949 pounds in 1922, 5,402,034 pounds in 1923, 6,783,240 pounds in 1924, and 6,463,192 pounds in 1925 of tubes, moldings, castings, and other shapes, table, kitchen, or hospital utensils, and other manufactures. Figures of quantity not available prior to 1922.³ Tubes, moldings, castings, and other shapes exported amounted to 2,115,274 pounds in 1926, 1,529,615 pounds in 1927, and 1,003,957 pounds in 1928; figures for quantity of table, kitchen, or hospital utensils, and other manufactures exported are not recorded.**BISMUTH**

The bismuth produced in the United States is a by-product obtained in the refining of lead and tin bullion, part of which is from ores of foreign origin. Figures of production are not available for publication.

Bismuth imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	57,607	\$55,179	1924 ¹	18,494	\$39,653
1920.....	72,771	161,877	1925 ¹	99,694	187,340
1921.....	94,085	114,891	1926 ¹	67,505	173,285
1922 ¹	121,505	239,777	1927 ¹	47,732	100,773
1923 ¹	62,640	146,178	1928 ¹	41,383	77,444

¹ Also 9,392 pounds of "compounds, mixtures, and salts of bismuth," valued at \$8,681, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to change in tariff. Similar additional imports in 1923 were 11,731 pounds, valued at \$13,717; in 1924, 10,066 pounds, \$12,533; in 1925, 16,983 pounds, \$18,958; in 1926, 12,864 pounds, \$18,864; in 1927, 10,560 pounds, \$15,080; and in 1928, 8,168 pounds, \$16,336.

Exports of bismuth are not separately recorded.

BORAX

[See Sodium salts (natural)]

BRIQUETS (FUEL)*Fuel briquets produced in the United States, 1919-1928*

Year	Short tons	Value	Year	Short tons	Value
1919.....	295, 734	\$2, 301, 054	1924.....	580, 470	\$4, 986, 022
1920.....	567, 192	4, 623, 831	1925.....	839, 370	7, 128, 404
1921.....	398, 949	3, 632, 301	1926.....	995, 332	8, 533, 179
1922.....	619, 425	5, 444, 926	1927.....	970, 408	7, 985, 165
1923.....	696, 810	5, 898, 698	1928.....	947, 423	7, 705, 617

Briquets and other composition coals for fuels imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	136	\$1, 050	1924.....	38	\$443
1920.....	(1)	9	1925.....	6, 758	43, 931
1921.....	66	251	1926.....	123, 593	736, 804
1922.....	34, 862	139, 382	1927.....	60, 601	314, 435
1923.....	19, 559	103, 201	1928.....	71, 485	353, 168

¹ 112 pounds.**BROMINE***Bromine and bromine in compounds sold or used by producers in the United States, 1919-1928*

Year	Pounds	Value	Year	Pounds	Value
1919.....	1, 854, 971	\$1, 234, 969	1924.....	2, 063, 804	\$594, 685
1920.....	1, 160, 584	745, 381	1925.....	1, 566, 120	488, 406
1921.....	711, 953	172, 759	1926.....	1, 245, 760	426, 837
1922.....	1, 005, 174	150, 608	1927.....	1, 756, 310	564, 689
1923.....	842, 352	146, 176	1928.....	2, 164, 000	649, 475

Imports of bromine have been as follows: 1928 and 1927, none; 1926, 37,839 pounds, valued at \$14,486; 1925, 8,009 pounds, \$2,110; 1924, 37,318 pounds, \$8,958; 1923, 782 pounds, \$1,171; 1922, 1,094 pounds, \$339; 1921, 300 pounds, \$84. No imports were recorded for 1919 and 1920.

Exports are not specifically shown.

CADMIUM

Cadmium produced in the United States, 1919-1928

Year	Metallic cadmium		Cadmium compounds	
	Pounds	Value	Estimated cadmium content (pounds)	Value
1919.....	99,939	\$121,926	¹ 23,400	¹ \$37,436
1920.....	129,283	151,261	¹ 24,100	¹ 37,274
1921.....	68,501	67,131	¹ 49,100	¹ 71,336
1922.....	131,590	143,433	¹ 101,100	¹ 152,295
1923.....	183,816	161,758	(2)	(2)
1924.....	129,328	77,597	(2)	(2)
1925.....	502,824	276,553	113,000	127,304
1926.....	810,428	429,527	166,600	130,483
1927.....	1,074,654	³ 645,000	229,000	191,051
1928.....	1,875,896	1,144,297	239,900	228,013

¹ Cadmium sulphide only.² Bureau of Mines not at liberty to publish figures.³ Value in 1927 based on the average market quotation of 60 cents a pound.*Metallic cadmium imported for consumption in the United States, 1919-1928*

Year	Pounds	Value	Year	Pounds	Value
1919-20.....			1925.....	5	\$6
1921.....	101	\$216	1926.....		
1922.....	2,240	2,434	1927.....	22,400	13,172
1923.....	16	119	1928.....	233,101	128,901
1924.....	1,102	743			

Exports of cadmium are not separately recorded by the Bureau of Foreign and Domestic Commerce, and hence are not regularly available, but it is known that domestic cadmium was largely exported during the World War.

CALCIUM CHLORIDE

Calcium-magnesium chloride, from natural brines, sold by producers in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	26,123	\$321,596	1924.....	58,791	\$1,164,848
1920.....	27,849	539,471	1925.....	67,870	1,386,639
1921.....	23,672	510,723	1926.....	82,340	1,710,405
1922.....	33,067	571,326	1927.....	95,721	1,947,797
1923.....	44,961	663,384	1928.....	102,090	1,995,603

Imports of calcium chloride have been as follows: 1928, 9,263 short tons, valued at \$100,223; 1927, 6,514 tons, \$85,456; 1926, 7,372 tons, \$96,742; 1925, 2,253 tons, \$37,121; 1924, 3,996 tons, \$54,542; 1923, 3,232 tons, \$48,527. From September 22 to December 31, 1922, 740 tons, valued at \$8,563, was imported. Similar imports were not separately recorded prior to change in tariff.

Exports of calcium chloride are not separately shown.

CARBON BLACK

Carbon black produced from natural gas in the United States, 1919-1928

Year	Number of producers reporting	Carbon black produced		Natural gas used (estimate)
		Pounds	Value at plant	M cubic feet
1919.....	17	52,056,941	\$3,816,040	49,896,000
1920.....	19	51,321,892	4,032,286	40,599,000
1921.....	23	59,766,315	5,445,878	50,565,000
1922.....	26	67,795,129	5,819,618	53,629,000
1923.....	47	138,262,648	11,692,066	109,096,000
1924.....	46	186,872,034	11,564,936	156,514,000
1925.....	42	177,417,378	9,639,585	140,306,000
1926.....	33	180,576,176	9,939,221	130,321,000
1927.....	33	198,429,000	10,955,000	144,087,000
1928.....	31	248,790,000	13,782,000	175,137,000

Imports of carbon black are not separately recorded.

Exports were not separately recorded until 1925 when they were 43,182,635 pounds, valued at \$3,555,769. Similar exports in 1926 were 39,210,389 pounds, valued at \$3,622,907; in 1927, 54,430,811 pounds, valued at \$4,599,734; and in 1928, 77,903,153 pounds, valued at \$6,794,224.

CEMENT

Hydraulic cements shipped from mills in the United States, 1919-1928

Year	Masonry, natural, and puzzolan cements		Portland cement		Total	
	Barrels	Value	Barrels	Value	Barrels	Value
1919.....	528,589	\$583,554	85,612,899	\$146,734,844	86,141,488	\$147,318,398
1920.....	767,481	1,150,890	96,311,719	194,439,025	97,079,200	195,589,915
1921.....	539,402	897,025	95,507,147	180,778,415	96,046,549	181,675,440
1922.....	889,428	1,293,598	117,701,216	207,170,430	118,590,644	208,464,028
1923.....	1,271,674	1,947,352	135,912,118	257,684,424	137,183,792	259,631,776
1924.....	1,418,461	2,006,559	146,047,549	264,046,708	147,466,010	266,053,267
1925.....	1,751,725	2,551,583	157,295,212	278,524,108	159,046,937	281,075,691
1926.....	2,031,851	2,820,110	162,187,090	277,965,473	164,218,941	280,785,583
1927.....	2,158,323	2,881,029	171,864,728	278,854,647	174,023,051	281,735,676
1928.....	2,213,645	2,910,097	175,838,332	275,972,945	178,051,977	278,883,042

Portland cement produced in the United States, 1919-1928, in barrels

1919.....	80,777,935	1924.....	149,358,109
1920.....	100,023,245	1925.....	161,658,901
1921.....	98,842,049	1926.....	164,530,170
1922.....	114,789,984	1927.....	173,206,513
1923.....	137,460,238	1928.....	176,298,846

Portland cement produced, shipped, and in stock in the United States, 1927 and 1928, by States and districts

	Production				Shipments				Stock at mills (Dec. 31) (barrels)	
	Active plants		Barrels		1927		1928		1927	1928
	1927	1928	1927	1928	Barrels	Value	Barrels	Value		
STATE	6	6	7,564,863	6,749,202	7,313,494	\$10,615,428	6,696,684	\$8,233,872	655,024	707,542
Alabama.....	12	12	14,580,654	13,555,579	14,433,153	26,623,396	13,699,851	25,906,942	840,566	696,234
California.....	4	4	7,017,047	7,334,833	7,061,240	11,312,783	7,405,667	11,602,848	768,275	697,441
Illinois.....	5	6	5,415,144	7,070,172	5,661,234	9,124,405	6,880,731	10,734,838	1,370,481	1,559,922
Iowa.....	7	7	6,180,255	6,574,219	6,141,937	9,939,412	6,787,968	10,691,330	1,137,286	1,923,937
Kansas.....	15	14	13,965,241	13,848,561	13,708,239	20,858,202	14,044,230	19,268,707	2,206,202	2,010,533
Michigan.....	5	5	6,778,384	7,881,118	6,929,229	11,117,047	7,943,367	12,367,018	957,053	894,804
Missouri.....	11	10	10,775,375	10,960,204	10,531,092	16,380,090	10,983,950	16,748,773	1,528,718	1,504,972
New York.....	10	8	8,853,869	9,233,033	8,727,879	14,242,901	9,364,338	14,928,183	1,205,379	1,074,074
Ohio.....	25	26	43,732,278	41,522,401	42,909,513	66,711,069	41,161,019	62,572,588	5,868,169	6,229,551
Pennsylvania.....	5	6	4,430,439	4,689,703	4,343,337	6,580,732	4,634,280	6,322,213	515,245	570,668
Tennessee.....	7	7	5,655,835	6,345,604	5,692,350	10,232,908	6,231,083	10,938,646	407,403	521,924
Texas.....	41	42	38,257,129	40,534,217	38,412,011	65,116,274	40,005,564	66,256,987	4,997,641	5,526,294
Other States 1.....	153	156	173,206,513	176,298,846	171,864,728	278,854,647	175,833,332	275,972,945	22,457,382	22,917,896
DISTRICT										
Eastern Pennsylvania, New Jersey, and Maryland.....	24	25	42,687,200	39,677,010	41,656,489	64,614,336	39,738,910	60,236,388	5,471,989	5,410,089
New York and Maine 2.....	11	12	10,775,375	11,484,054	10,531,092	16,380,090	11,357,052	17,386,416	1,528,718	1,655,720
Ohio, western Pennsylvania, and West Virginia.....	18	18	17,339,199	18,326,478	17,202,341	27,638,726	18,037,131	28,375,472	2,571,795	2,881,142
Michigan.....	15	14	13,965,241	13,848,561	13,708,239	20,858,202	14,044,230	19,268,707	2,206,202	2,010,533
Wisconsin, Illinois, Indiana, and Kentucky.....	11	11	22,072,150	22,748,604	22,394,739	36,274,654	22,627,309	35,575,358	2,614,241	2,735,536
Virginia, Tennessee, Alabama, Georgia, Florida, and Louisiana.....	18	19	16,016,154	15,949,537	15,530,338	23,668,315	15,770,338	21,253,288	1,680,032	1,859,231
Eastern Missouri, Iowa, Minnesota, and South Dakota.....	11	12	14,358,201	16,692,696	14,566,818	23,325,158	16,544,026	25,777,858	2,731,067	2,879,737
Western Missouri, Nebraska, Kansas, and Oklahoma.....	11	11	10,092,888	10,938,037	10,250,532	16,869,793	11,221,802	17,444,193	1,629,230	1,346,065
Texas.....	7	7	5,655,835	6,345,604	5,692,350	10,232,908	6,231,083	10,938,646	407,403	521,924
Colorado, Montana, and Utah.....	8	7	2,179,241	2,771,863	2,293,514	4,692,136	2,628,003	5,698,753	380,450	524,310
California.....	12	12	14,580,654	13,555,579	14,433,153	26,623,396	13,699,851	25,906,942	840,566	696,234
Oregon and Washington.....	7	8	3,534,375	3,960,223	3,605,103	7,736,933	3,938,597	8,110,924	395,749	417,375
	153	156	173,206,513	176,298,846	171,864,728	278,854,647	175,838,332	275,972,945	22,457,382	22,917,896

¹ 1927: Colorado, Florida, Georgia, Indiana, Kentucky, Louisiana, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oklahoma, Oregon, South Dakota, Utah, Virginia, Washington, West Virginia, and Wisconsin; 1928: Same States as in 1927, with Maine in addition.

² Maine began producing in April, 1928; shipping in May, 1928.

Hydraulic cement imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Barrels	Value	Barrels	Value
1919.....	8,931	\$52,636	2,463,573	\$7,513,389
1920.....	524,604	1,254,729	2,985,807	10,045,369
1921.....	122,317	388,842	1,181,014	4,276,986
1922.....	355,931	692,429	1,127,845	3,206,201
1923.....	1,767,264	3,145,977	1,001,688	2,944,174
1924.....	2,023,663	3,139,788	878,543	2,615,154
1925.....	3,667,458	5,836,482	1,019,597	3,003,128
1926.....	3,244,223	5,154,926	974,326	2,995,833
1927.....	2,065,730	3,007,103	816,726	2,796,717
1928.....	2,302,475	3,135,558	824,656	2,938,702

CHROMITE*Chromite shipped from mines in the United States, 1919-1928*

Year	Long tons	Value	Year	Long tons	Value
1919.....	5,079	\$129,302	1924.....	288	\$1,140
1920.....	2,502	44,857	1925.....	108	2,105
1921.....	282	2,900	1926.....	141	2,079
1922.....	355	7,288	1927.....	1201	15,063
1923.....	227	3,819	1928.....	660	14,807

¹ No shipments reported by producers to the Bureau of Mines for 1927. Division of Mines and Mining, Department of Natural Resources, California, reports 225 short tons, valued at \$5,063 f. o. b. shipping point, as sold in 1927.

Crude chromite imported for consumption in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919.....	61,404	\$1,381,497	1924.....	118,343	\$1,095,603
1920.....	150,275	1,921,824	1925.....	149,739	1,207,420
1921.....	81,836	654,602	1926.....	215,464	1,704,947
1922.....	90,081	741,186	1927.....	222,360	1,748,598
1923.....	129,693	1,123,120	1928.....	216,592	1,704,988

There are no exports of chromite.

CLAY*Clay sold by producers in the United States, 1919-1928*

Year	Kaolin or china clay and paper clay		Ball clay		Slip clay		Fire clay	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	152,828	\$1,475,681	65,026	\$520,849	5,149	\$17,556	1,755,331	\$4,628,605
1920.....	268,203	2,865,407	69,477	584,611	9,006	41,519	2,261,915	7,088,049
1921.....	162,726	1,579,163	54,014	354,565	4,608	14,841	1,195,861	3,560,373
1922.....	275,675	2,346,095	76,792	440,877	4,050	19,405	1,679,220	4,633,486
1923.....	336,803	2,926,255	97,068	620,978	8,520	43,609	2,298,163	6,565,899
1924.....	326,611	2,923,965	83,034	581,966	5,910	31,023	2,443,710	6,737,063
1925.....	367,319	3,220,719	109,607	699,427	7,349	37,397	2,566,934	7,312,349
1926.....	432,215	3,771,568	112,195	867,500	8,644	45,959	2,819,346	8,119,323
1927.....	454,245	3,809,834	119,763	913,976	6,137	32,264	2,699,761	7,719,725
1928.....	496,142	4,088,003	120,878	984,075	5,699	30,796	2,785,158	7,480,609

Clay sold by producers in the United States, 1919-1928—Continued

Year	Stoneware clay		Miscellaneous clay		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	60,236	\$80,367	236,530	\$367,573	2,275,100	\$7,090,631
1920.....	106,350	229,221	322,100	467,856	3,037,051	11,276,663
1921.....	86,574	184,540	242,963	361,818	1,746,746	6,055,500
1922.....	86,866	164,870	525,097	725,781	2,647,700	8,330,514
1923.....	81,389	194,358	612,717	837,814	3,434,660	11,188,913
1924.....	59,194	117,142	772,660	1,116,377	3,691,119	11,507,536
1925.....	77,438	162,161	901,773	1,304,579	4,030,420	12,736,632
1926.....	84,002	185,288	510,796	1,115,951	3,967,198	14,105,589
1927.....	98,355	203,648	470,915	1,017,712	3,849,176	13,697,159
1928.....	95,626	207,275	522,829	1,409,981	4,026,332	14,200,739

Clay imported for consumption in the United States, 1919-1928

Year	Kaolin or china clay		Common blue and Gross Almerode glass- pot clay		All other clays				Total	
					Unwrought		Wrought			
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1919-----	180,592	\$1,965,393	4	\$133	23,759	\$187,550	498	\$4,262	204,853	\$2,157,338
1920-----	361,800	3,568,677	6,837	157,201	34,252	272,524	691	10,267	403,580	4,008,669
1921-----	162,906	1,546,285	4,468	77,217	41,421	348,870	120	2,313	208,915	1,974,685
1922-----	310,136	2,963,420	7,323	84,415	40,624	327,388	2,566	29,398	360,649	3,404,621
1923-----	311,298	3,046,191	12,999	121,272	65,379	481,614	1,676	21,892	391,352	3,670,969
1924-----	353,124	3,188,454	7,059	62,883	82,562	706,018	1,322	18,685	444,067	3,976,040
1925-----	372,552	3,195,694	11,889	107,940	49,991	499,325	2,383	29,266	436,815	3,832,225
1926-----	396,219	3,484,054	6,608	60,391	84,512	672,223	2,331	31,243	489,670	4,247,911
1927-----	339,014	2,937,113	3,884	39,451	50,017	447,888	1,585	24,518	394,500	3,448,970
1928-----	307,304	2,962,269	10,259	90,742	51,163	429,788	1,653	23,564	370,379	3,506,363

Domestic clay exported from the United States, 1919-1928

Year	Fire clay		All other		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	37,486	\$262,501	30,983	\$249,571	68,469	\$512,072
1920.....	54,125	393,177	66,035	775,222	120,160	1,168,399
1921.....	23,666	177,979	23,779	183,449	47,445	361,428
1922.....	24,391	169,664	23,285	126,908	47,676	437,889
1923.....	50,055	303,675	34,840	329,192	84,895	632,867
1924.....	41,704	312,676	31,051	420,040	72,755	732,716
1925.....	44,037	350,571	39,006	530,995	83,043	881,566
1926.....	47,737	348,302	42,157	644,416	89,894	992,718
1927.....	48,106	392,327	51,278	725,562	99,384	1,117,889
1928.....	60,138	494,241	60,911	896,350	121,049	1,390,591

¹ Includes 2,091 short tons of "kaolin, china, and paper clay," valued at \$27,840. Similar exports not shown separately for other years.

CLAY PRODUCTS

*Value of clay products of the United States, 1919-1928*¹

Year	Brick and tile	Pottery	Total	Year	Brick and tile	Pottery	Total
1919.....	\$197,488,616	\$77,857,762	\$275,346,378	1924....	\$297,764,393	\$118,014,985	\$415,779,378
1920.....	266,953,426	106,716,676	373,670,102	1925.....	311,428,417	112,018,500	423,446,917
1921.....	186,589,507	84,149,029	270,738,536	1926.....	313,935,186	116,493,308	430,428,494
1922.....	² 229,508,106	91,986,297	² 321,494,403	1927.....	292,322,616	111,612,931	403,935,547
1923.....	309,631,561	114,951,067	424,582,628	1928.....	265,770,513	107,780,369	373,550,882

¹ Canvass discontinued by U. S. Geological Survey after 1920. Figures for 1921 to 1928 obtained through cooperation with Bureau of the Census.

² Includes value of "prepared clay," figures for which are not separately published.

*Clay products of the United States, 1927 and 1928, by products*¹

Product	1927		1928	
	Quantity	Value	Quantity	Value
Common brick.....thousands..	7,060,984	\$78,407,745	6,412,810	\$69,332,912
Vitrified brick or block.....do....	503,400	10,763,724	378,459	7,800,090
Face brick.....do.....	2,412,903	41,520,881	2,411,575	40,034,273
Fancy or ornamental brick.....do....	1,456	108,451	146	4,065
ENAMELED brick.....do.....	18,097	1,374,725	15,407	1,135,266
Hollow brick.....do.....	37,040	436,065	34,202	366,746
Architectural terra cotta.....short tons..	155,932	16,628,139	142,720	13,641,777
Fireproofing and hollow building tile.....do....	4,114,309	26,499,380	3,976,311	25,791,634
Flue lining.....do.....	252,019	2,851,526	250,796	2,693,098
Tile (not drain).....do.....		32,766,412		31,523,096
Drain tile.....short tons..	734,392	5,511,301	694,205	5,256,220
Sewer pipe.....do.....	2,115,688	29,425,913	1,895,487	23,968,773
Stove lining.....do.....	13,646	503,021	9,706	343,907
Fire brick:				
Standard.....thousands..	877,718	35,474,393	868,755	34,873,537
Special shapes.....short tons..	132,618	2,699,485	86,671	2,518,198
Glass-house tank blocks, melting pots, etc.....do....	41,177	2,310,473	35,513	1,993,609
Wall coping.....do.....	52,841	670,505	58,000	663,131
Miscellaneous.....do.....		4,370,477		3,830,181
Total brick and tile.....do.....		292,322,616		265,770,513
Total pottery.....do.....		111,612,931		107,780,369
Grand total.....do.....		403,935,547		373,550,882

¹ Figures obtained through cooperation with Bureau of the Census.

Value of clay products of the United States, 1927 and 1928, by States -

State	1927				1928			
	Number of firms reporting	Brick and tile	Pottery	Total	Number of firms reporting	Brick and tile	Pottery	Total
Alabama.....	39	\$4, 823, 670	(?)	³ \$4, 823, 670	38	\$4, 066, 882	\$5, 920	\$4, 072, 802
Arizona.....	8	345, 391	-----	345, 391	7	297, 159	-----	297, 159
Arkansas.....	13	1, 285, 720	(?)	³ 1, 285, 720	15	1, 580, 571	(?)	³ 1, 580, 571
California.....	114	17, 391, 576	\$3, 602, 914	20, 994, 490	117	16, 721, 960	4, 271, 387	20, 993, 347
Colorado.....	35	2, 998, 486	(?)	³ 2, 998, 486	33	2, 644, 850	353, 392	2, 998, 242
Connecticut.....	28	2, 652, 640	(?)	³ 2, 652, 640	24	2, 558, 384	(?)	³ 2, 558, 384
Delaware.....	8	293, 089	-----	293, 089	7	274, 894	-----	274, 894
District of Columbia.....	4	(?)	(?)	(?)	4	211, 020	(?)	³ 211, 020
Florida.....	12	462, 190	-----	³ 462, 190	11	392, 048	(?)	³ 392, 048
Georgia.....	40	4, 853, 932	25, 804	4, 879, 736	35	3, 644, 931	11, 558	3, 656, 489
Idaho.....	6	205, 993	-----	205, 993	6	188, 232	-----	188, 232
Illinois.....	127	29, 319, 507	5, 133, 098	34, 452, 605	129	26, 328, 670	5, 698, 215	32, 026, 885
Indiana.....	98	14, 230, 400	3, 625, 571	17, 855, 971	90	12, 932, 816	3, 613, 895	16, 546, 711
Iowa.....	53	5, 158, 104	(?)	³ 5, 158, 104	49	5, 006, 623	(?)	³ 5, 006, 623
Kansas.....	30	3, 805, 509	(?)	³ 3, 805, 509	29	3, 593, 130	(?)	³ 3, 593, 130
Kentucky.....	44	7, 257, 664	(?)	³ 7, 257, 664	42	6, 954, 582	158, 941	7, 113, 523
Louisiana.....	14	446, 156	(?)	³ 446, 156	13	284, 114	(?)	³ 284, 114
Maine.....	16	680, 739	-----	680, 739	20	535, 088	-----	535, 088
Maryland.....	26	2, 503, 935	(?)	³ 2, 503, 935	24	2, 161, 720	2, 424, 905	4, 586, 625
Massachusetts.....	40	2, 398, 474	(?)	³ 2, 398, 474	37	2, 029, 287	800, 323	2, 829, 610
Michigan.....	39	3, 892, 646	2, 879, 637	6, 772, 283	34	3, 019, 297	3, 291, 289	6, 310, 586
Minnesota.....	24	1, 675, 662	(?)	³ 1, 675, 662	25	1, 492, 792	(?)	³ 1, 492, 792
Mississippi.....	24	1, 146, 472	(?)	³ 1, 146, 472	26	1, 094, 259	35, 540	1, 129, 799
Missouri.....	57	16, 322, 322	69, 849	16, 392, 171	56	14, 891, 273	(?)	³ 14, 891, 273
Montana.....	9	299, 622	-----	299, 622	10	397, 516	-----	397, 516
Nebraska.....	19	819, 494	(?)	³ 819, 494	17	794, 851	(?)	³ 794, 851
Nevada.....	1	(?)	-----	(?)	1	(?)	-----	(?)
New Hampshire.....	12	811, 626	-----	811, 626	14	881, 023	-----	881, 023
New Jersey.....	123	20, 370, 048	22, 729, 721	43, 099, 769	114	18, 160, 009	21, 219, 269	39, 379, 278
New Mexico.....	4	161, 666	-----	161, 666	4	166, 351	-----	166, 351
New York.....	114	17, 820, 424	7, 656, 472	25, 476, 896	102	15, 422, 513	7, 051, 892	22, 474, 405
North Carolina.....	72	3, 833, 258	27, 692	3, 860, 950	63	3, 787, 043	39, 450	3, 826, 493
North Dakota.....	4	130, 733	-----	130, 733	3	167, 121	-----	167, 121
Ohio.....	372	53, 856, 958	38, 738, 172	92, 595, 130	336	47, 867, 039	33, 981, 383	81, 848, 422
Oklahoma.....	19	1, 693, 669	-----	1, 693, 669	16	1, 726, 369	-----	1, 726, 369
Oregon.....	21	656, 563	(?)	³ 656, 563	14	450, 205	(?)	³ 450, 205
Pennsylvania.....	286	42, 749, 157	8, 239, 664	50, 988, 821	265	40, 861, 414	7, 067, 389	47, 928, 803
Rhode Island.....	1	(?)	-----	(?)	-----	-----	-----	-----
South Carolina.....	24	1, 802, 772	(?)	³ 1, 802, 772	24	1, 448, 765	13, 290	1, 462, 055
Tennessee.....	35	3, 728, 380	(?)	³ 3, 728, 380	34	3, 134, 891	895, 360	4, 030, 251
Texas.....	67	6, 219, 094	197, 923	6, 417, 017	58	5, 992, 538	184, 264	6, 176, 802
Utah.....	12	1, 024, 559	(?)	³ 1, 024, 559	11	444, 536	(?)	³ 444, 536
Vermont.....	2	(?)	-----	(?)	1	(?)	-----	(?)
Virginia.....	47	2, 932, 998	(?)	³ 2, 932, 998	44	2, 940, 832	(?)	³ 2, 940, 832
Washington.....	35	2, 465, 723	52, 527	2, 518, 250	27	1, 945, 317	23, 609	1, 968, 926
West Virginia.....	48	4, 895, 461	11, 424, 912	16, 320, 373	46	5, 019, 880	14, 007, 665	19, 027, 545
Wisconsin.....	36	1, 228, 338	(?)	³ 1, 228, 338	35	1, 007, 826	(?)	³ 1, 007, 826
Wyoming.....	4	101, 708	-----	101, 708	5	103, 426	-----	103, 426
Undistributed.....	-----	570, 088	7, 208, 975	7, 779, 063	-----	146, 466	2, 631, 433	2, 777, 899
	2, 266	292, 322, 616	111, 612, 931	403, 935, 547	2, 115	265, 770, 513	107, 780, 369	373, 550, 882

¹ Figures obtained through cooperation with Bureau of the Census.² Included under "Undistributed."³ Exclusive of pottery, value for which is included under "Undistributed."

Value of clay products imported for consumption in the United States, 1919-1928

Year	Pottery								Brick, fire brick, tile, and miscellaneous clay products	Grand total
	Brown earthen and common stoneware ¹	Tobacco pipes and pipe bowls of clay	Earthenware and crockery composed of a non-vitrified absorbent body		China and porcelain		Sanitary earthenware, decorated and not decorated	Total		
			Not decorated	Decorated	Not decorated	Decorated				
1919.....	\$293, 120	\$15, 852	\$350, 644	\$2, 476, 210	\$359, 560	\$3, 726, 695	\$7, 980	\$7, 230, 061	\$196, 839	\$7, 426, 900
1920.....	390, 962	12, 091	340, 676	3, 805, 955	431, 636	5, 856, 384	13, 038	10, 850, 772	252, 656	11, 103, 428
1921.....	288, 893	11, 535	405, 370	3, 871, 554	646, 427	6, 918, 179	12, 037	12, 154, 025	228, 804	12, 382, 829
1922.....	341, 997	15, 638	339, 066	4, 427, 001	641, 261	6, 298, 440	17, 295	12, 080, 698	375, 764	12, 456, 462
1923.....	263, 388	26, 606	881, 480	4, 916, 906	864, 239	8, 830, 266	346, 589	16, 129, 474	864, 124	16, 993, 598
1924.....	314, 721	14, 517	765, 070	5, 041, 570	799, 772	9, 504, 905	125, 100	16, 565, 655	690, 639	17, 256, 294
1925.....	401, 421	22, 385	544, 124	5, 679, 094	699, 792	9, 994, 062	5, 463	17, 346, 341	935, 507	18, 281, 848
1926.....	359, 951	21, 661	445, 436	6, 444, 433	623, 360	11, 383, 666	1, 873	19, 280, 380	1, 939, 843	21, 220, 223
1927.....	209, 736	10, 327	458, 141	7, 320, 731	578, 499	11, 875, 202	4, 950	20, 457, 586	1, 849, 355	22, 306, 941
1928.....	155, 539	11, 575	389, 332	6, 085, 149	476, 275	9, 338, 946	6, 626	16, 463, 442	1, 955, 629	18, 419, 071

¹ Including Rockingham ware and miscellaneous pottery products.*Value of clay products of domestic manufacture exported from the United States, 1919-1928*

Year	Building brick	Fire brick	Tile (except drain)	Earthen and stone-ware	China	Sanitary earthen-ware	All other	Total
1919.....	\$248, 690	\$2, 747, 512	\$628, 836	\$1, 148, 051	\$523, 861	\$563, 734	\$721, 600	\$6, 582, 284
1920.....	382, 814	4, 200, 266	1, 025, 083	1, 241, 938	816, 817	778, 714	951, 991	9, 397, 623
1921.....	415, 402	2, 314, 911	814, 456	1, 014, 329	312, 161	535, 506	873, 182	6, 279, 947
1922.....	210, 215	1, 581, 679	390, 408	981, 082	316, 973	561, 536	1, 599, 949	5, 641, 842
1923.....	282, 454	2, 332, 536	373, 866	932, 779	334, 146	657, 859	1, 915, 842	6, 829, 482
1924.....	222, 033	1, 463, 412	400, 452	753, 652	259, 098	745, 746	1, 863, 324	5, 707, 717
1925.....	194, 153	1, 323, 128	396, 088	758, 883	255, 578	788, 528	1, 041, 484	4, 757, 842
1926.....	176, 711	1, 405, 809	376, 162	694, 736	268, 796	1, 026, 636	1, 691, 131	5, 640, 981
1927.....	161, 346	3, 024, 156	391, 190	862, 396	338, 955	1, 198, 660	1, 310, 338	7, 287, 041
1928.....	263, 786	3, 543, 735	298, 494	817, 381	389, 675	1, 371, 005	1, 485, 776	8, 169, 852

¹ Includes electric porcelain valued at \$1,379,750 in 1922, \$1,783,614 in 1923, \$1,767,323 in 1924, \$949,785 in 1925, \$1,541,675 in 1926, \$1,201,481 in 1927, and \$1,375,764 in 1928; not separately classified prior to 1922.

COAL

Coal produced in the United States, 1919-1928

Year	Pennsylvania anthracite		Bituminous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	88, 092, 201	\$364, 926, 950	465, 860, 058	\$1, 160, 616, 013	553, 952, 259	\$1, 525, 542, 963
1920.....	89, 598, 249	434, 252, 198	568, 666, 683	2, 129, 933, 000	658, 264, 932	2, 564, 185, 000
1921.....	90, 473, 451	452, 304, 903	415, 921, 950	1, 199, 983, 600	506, 395, 401	1, 652, 288, 600
1922.....	54, 683, 022	273, 700, 125	422, 268, 099	1, 274, 820, 000	476, 951, 121	1, 548, 520, 000
1923.....	93, 339, 009	506, 786, 768	564, 564, 662	1, 514, 621, 000	657, 903, 671	2, 021, 408, 000
1924.....	87, 926, 862	477, 230, 852	483, 686, 538	1, 062, 626, 000	571, 613, 400	1, 539, 857, 000
1925.....	61, 817, 149	327, 664, 512	520, 052, 741	1, 060, 402, 000	581, 869, 890	1, 388, 067, 000
1926.....	84, 437, 452	474, 164, 252	573, 366, 985	1, 183, 412, 000	657, 804, 437	1, 657, 576, 000
1927.....	80, 095, 564	420, 941, 726	517, 763, 352	1, 029, 657, 000	597, 858, 916	1, 450, 599, 000
1928.....	75, 348, 069	393, 637, 690	500, 744, 970	933, 774, 000	576, 093, 039	1, 327, 412, 000

Coal produced in the United States, 1927 and 1928, by States

[Exclusive of product of wagon mines]

State	1927		1928	
	Short tons	Value	Short tons	Value
Alabama.....	19,765,866	\$44,524,000	17,621,362	\$39,601,000
Alaska.....	104,300	548,000	126,100	662,000
Arizona.....	4,583	6,000	3,600	16,000
Arkansas.....	1,548,834	5,393,000	1,660,973	5,615,000
California, Idaho, Nevada, ¹ and Oregon.....	27,841	85,000	23,888	70,000
Colorado.....	9,724,075	27,044,000	9,847,707	27,613,000
Georgia.....	76,712	233,000	58,390	181,000
Illinois.....	46,848,224	101,350,000	55,948,199	112,095,000
Indiana.....	17,935,758	36,381,000	16,378,580	29,212,000
Iowa.....	2,949,622	9,304,000	3,683,635	10,525,000
Kansas.....	3,443,762	9,648,000	2,809,724	6,861,000
Kentucky.....	69,123,998	119,249,000	61,860,379	96,722,000
Maryland.....	2,814,842	5,817,000	2,686,979	4,954,000
Michigan.....	756,763	3,262,000	617,342	2,631,000
Missouri.....	3,064,343	8,698,000	3,732,421	9,637,000
Montana.....	3,143,638	7,403,000	3,324,195	7,550,000
New Mexico.....	2,935,539	9,179,000	2,711,851	8,636,000
North Carolina.....	53,377	191,000	60,860	201,000
North Dakota.....	1,527,939	2,604,000	1,649,930	2,780,000
Ohio.....	15,799,697	30,376,000	15,641,225	26,439,000
Oklahoma.....	3,818,054	11,570,000	3,501,325	10,365,000
Pennsylvania, bituminous.....	132,964,639	272,714,000	131,202,163	249,895,000
South Dakota.....	12,507	38,000	13,929	39,000
Tennessee.....	5,783,367	10,645,000	5,610,959	9,694,000
Texas.....	1,326,385	1,998,000	1,182,034	1,589,000
Utah.....	4,781,480	11,084,000	4,842,544	12,253,000
Virginia.....	12,916,042	23,203,000	11,900,933	20,375,000
Washington.....	2,635,062	9,222,000	2,519,901	8,720,000
West Virginia.....	145,122,447	249,730,000	132,952,159	211,480,000
Wyoming.....	6,753,656	18,152,000	6,571,683	17,363,000
Total bituminous.....	517,763,352	1,029,657,000	500,744,970	933,774,000
Pennsylvania anthracite.....	80,095,564	420,941,726	75,348,069	393,637,690
Grand total.....	597,858,916	1,450,599,000	576,093,039	1,327,412,000

¹ Production reported from Nevada for 1927 only.*Coal produced in the United States, 1927 and 1928, by months, in short tons*

Month	Pennsylvania anthracite		Bituminous	
	1927	1928	1927	1928
January.....	6,516,000	5,587,000	56,660,000	44,925,000
February.....	5,812,000	5,481,000	52,697,000	42,022,000
March.....	6,056,000	5,398,000	59,911,000	44,668,000
April.....	7,078,000	6,784,000	34,538,000	32,710,000
May.....	7,947,000	7,977,000	35,256,000	37,218,000
June.....	7,207,000	5,205,000	36,483,000	36,546,000
July.....	4,993,000	4,394,000	33,505,000	36,864,000
August.....	7,694,000	6,759,000	41,541,000	41,774,000
September.....	6,596,000	5,927,000	41,763,000	41,971,000
October.....	7,353,000	8,400,000	43,827,000	51,176,000
November.....	6,854,000	7,322,000	40,468,000	46,788,000
December.....	5,990,000	6,114,000	41,114,000	44,083,000
	80,096,000	75,348,000	517,763,000	500,745,000

Coal imported for consumption in the United States, 1919-1928

Year	Anthracite		Bituminous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	82,818	\$522,419	1,011,550	\$4,950,686	1,094,368	\$5,473,105
1920.....	31,748	257,835	1,244,990	6,733,676	1,276,738	6,991,511
1921.....	8,894	93,103	1,257,589	7,363,945	1,266,483	7,457,048
1922.....	233,528	1,502,192	5,059,999	26,747,374	5,293,527	28,249,566
1923.....	300,360	2,114,080	1,881,465	10,128,516	2,181,825	12,242,596
1924.....	117,914	880,364	416,736	2,135,402	534,650	3,015,766
1925.....	382,894	3,212,505	601,737	2,633,980	984,631	5,846,485
1926.....	813,956	6,996,739	485,298	2,300,570	1,299,254	9,297,309
1927.....	119,030	837,033	548,278	2,435,212	667,308	3,272,245
1928.....	354,707	2,591,041	547,505	2,402,083	932,212	4,993,124

Coal exported from the United States, 1919-1928

Year	Anthracite		Bituminous ¹		Total ¹	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	4,976,598	\$36,668,131	20,113,536	\$83,708,842	25,090,134	\$120,376,973
1920.....	5,403,749	45,538,100	38,517,084	304,273,241	43,920,833	349,811,341
1921.....	4,677,368	45,624,555	23,131,166	122,597,038	27,808,534	168,221,593
1922.....	2,649,457	25,350,677	12,413,085	65,891,740	15,062,542	91,242,417
1923.....	5,090,138	49,577,339	21,453,579	104,546,585	26,543,717	154,123,924
1924.....	4,017,785	40,067,804	17,100,347	70,971,302	21,118,132	111,039,106
1925.....	3,179,006	31,760,627	17,461,560	68,402,668	20,640,566	100,163,295
1926.....	4,029,683	41,085,946	35,271,937	155,818,572	39,301,620	196,904,518
1927.....	3,325,507	32,927,796	18,011,744	71,328,924	21,337,251	104,256,720
1928.....	3,336,272	32,656,523	16,164,485	59,464,348	19,500,757	92,120,871

¹ Exclusive of bunker coal, which has been as follows: 1919, 8,223,862 short tons, valued at \$48,205,675; 1920, 10,485,639 tons, \$82,461,518; 1921, 8,453,220 tons, \$52,277,668; 1922, 4,614,632 tons, \$27,912,957; 1923, 5,093,024 tons, \$31,469,788; 1924, 4,460,412 tons, \$22,883,293; 1925, 4,865,521 tons, \$23,397,831; 1926, 7,735,606 tons, \$38,025,411; 1927, 4,565,278 tons, \$22,077,203; 1928, 4,294,223 tons, \$20,558,057.

COBALT

No cobalt ores are known to have been produced in the United States in 1922 to 1928. Production in other years of the decade 1919 to 1928 has been as follows: 1919, concentrates carrying approximately 18 per cent of cobalt were produced in Idaho, and cobalt oxide mined and reduced near Fredericktown, Mo., contained 28 pounds of cobalt, valued at \$122,452; 1920, 102,410 pounds of cobalt in oxide and hydrate, valued at \$262,801, was recovered from ore mined near Fredericktown, Mo.; 1921, 42,086 pounds of heterogenite (cobalt oxide), containing 4,018 pounds of cobalt, was mined near Goodsprings, Nev.; it was shipped in 1922 and sold for \$1,419.

Cobalt ore, cobalt, and oxide imported for consumption in the United States, 1919-1928

Year	Ore		Cobalt		Oxide		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919.....	17,045	\$2,832	60,511	\$141,450	131,424	\$184,751	208,980	\$329,033
1920.....	13,039	4,794	143,603	326,864	202,724	399,605	1,359,586 ¹	1,731,277
1921.....	7,657	3,235	38,442	105,539	164,003	342,426	210,102	451,200
1922.....	5,195	7,075	128,364	321,396	217,530	435,895	2,349,089	2,764,366
1923.....	58,719	56,326	225,639	552,434	258,574	511,903	2,542,932	2,120,663
1924.....	28,786	37,276	118,952	264,935	226,703	440,898	2,374,441	2,743,109
1925.....	34,782	31,320	198,669	422,185	287,265	546,292	2,520,716	2,999,797
1926.....	154,468	55,820	387,076	820,873	333,132	632,478	1,874,786	2,509,211
1927.....	60,382	3,019	407,198	841,442	369,747	703,608	2,837,327	2,154,069
1928.....	107,498	25,922	535,817	1,147,574	364,154	692,753	2,007,469	2,186,649

¹ Includes 220 pounds of zaffer, valued at \$14, in 1920, and 110 pounds, valued at \$40, in 1926. No zaffer imported 1919, 1921 to 1925, 1927, and 1928.

² Also 11 pounds of "other salts and compounds," valued at \$26, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to change in tariff. Similar additional imports in 1923 were 45,644 pounds, valued at \$27,356; in 1924, 797 pounds, \$856; in 1925, 13,256 pounds, \$7,894; in 1926, 37,342 pounds, \$21,647; in 1927, 55,127 pounds, \$23,681; and in 1928, 68,281 pounds, \$39,903.

COKE AND COKE-OVEN BY-PRODUCTS

COKE

Coke produced in the United States, 1919-1928

Year	Beehive		By-product		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	19, 042, 936	\$98, 094, 972	25, 137, 621	\$160, 244, 768	44, 180, 557	\$258, 339, 740
1920.....	20, 511, 092	162, 952, 483	30, 833, 951	313, 028, 732	51, 345, 043	475, 981, 215
1921.....	5, 538, 042	30, 166, 449	19, 749, 580	117, 506, 646	25, 287, 622	147, 673, 095
1922.....	8, 573, 467	50, 036, 556	28, 550, 545	188, 276, 767	37, 124, 012	238, 313, 323
1923.....	19, 379, 870	115, 905, 580	37, 597, 664	257, 591, 318	56, 977, 534	373, 496, 898
1924.....	10, 286, 037	48, 351, 552	33, 983, 568	195, 690, 009	44, 269, 605	244, 041, 561
1925.....	11, 354, 784	51, 731, 566	39, 912, 159	210, 827, 571	51, 266, 943	262, 559, 137
1926.....	12, 488, 951	57, 024, 869	44, 376, 586	250, 748, 533	56, 865, 537	307, 773, 402
1927.....	7, 207, 417	30, 276, 775	43, 884, 726	232, 043, 803	51, 092, 143	262, 320, 578
1928.....	4, 492, 803	16, 318, 556	48, 313, 025	236, 515, 204	52, 805, 828	252, 833, 760

Coke produced in the United States, 1927 and 1928, by States

State	1927		1928	
	Short tons	Value ¹	Short tons	Value ¹
Alabama.....	4, 364, 354	\$13, 500, 234	4, 327, 324	\$13, 260, 178
Colorado.....	788, 586	(2)	750, 022	(2)
Connecticut.....	(3)	(3)	(3)	(3)
Georgia.....	(3)	(3)	(3)	(3)
Illinois.....	3, 013, 940	21, 076, 519	3, 240, 964	19, 967, 463
Indiana.....	5, 549, 762	37, 152, 981	6, 094, 201	38, 237, 790
Kentucky.....	(2)	(3)	(3)	(3)
Maryland.....	1, 077, 309	(2)	1, 186, 398	(2)
Massachusetts.....	744, 091	6, 008, 556	687, 356	5, 269, 890
Michigan.....	1, 920, 394	12, 227, 241	2, 399, 656	13, 461, 466
Minnesota.....	632, 628	6, 212, 501	622, 696	5, 816, 566
Missouri.....	(3)	(3)	(3)	(3)
New Jersey.....	906, 321	(2)	903, 177	(2)
New York.....	3, 602, 642	24, 125, 451	3, 802, 657	25, 033, 649
Ohio.....	(3)	(3)	(3)	(3)
Pennsylvania.....	16, 777, 291	67, 170, 075	16, 917, 355	62, 647, 772
Rhode Island.....	(3)	(3)	(3)	(3)
Tennessee.....	227, 120	1, 149, 604	216, 925	1, 063, 887
Utah.....	282, 048	(2)	274, 600	(2)
Virginia.....	316, 754	1, 413, 595	247, 734	1, 052, 016
Washington.....	71, 271	530, 759	59, 502	437, 187
West Virginia.....	1, 923, 427	6, 840, 358	1, 798, 900	5, 305, 393
Wisconsin.....	(3)	(3)	(3)	(3)
Combined States.....	8, 894, 205	46, 626, 817	9, 276, 361	43, 907, 601
Undistributed.....		18, 285, 887		17, 282, 902
	51, 092, 143	262, 320, 578	52, 805, 828	252, 833, 760

¹ Includes operators' statements of value for that portion of product not sold (such as coke consumed by producer in associated iron furnaces).

² Included under "Undistributed."

³ Included under "Combined States."

Coke produced in the United States, 1927 and 1928, by States and kinds

State	Beehive				By-product			
	1927		1928		1927		1928	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama					4,364,354	\$13,500,234	4,327,324	\$13,260,178
Colorado	194,184	(1)	144,200	(1)	594,402	(1)	605,822	(1)
Connecticut							(2)	(2)
Georgia	(2)	(2)	(2)	(2)				
Illinois					3,013,940	21,076,519	3,240,964	19,967,463
Indiana					5,549,762	37,152,981	6,004,201	38,237,790
Kentucky	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Maryland					1,077,309	(1)	1,186,398	(1)
Massachusetts					744,091	6,008,556	687,356	5,269,890
Michigan					1,920,394	12,227,241	2,399,656	13,461,466
Minnesota					632,623	6,212,501	622,696	5,816,566
Missouri					(2)	(2)	(2)	(2)
New Jersey					906,321	(1)	903,177	(1)
New York					3,602,642	24,125,451	3,802,657	25,033,649
Ohio	(2)	(2)	(2)	(2)	7,213,619	34,684,465	7,786,199	33,908,863
Pennsylvania	5,716,207	\$22,568,318	3,442,006	\$11,515,356	11,061,084	44,601,757	13,475,349	51,132,406
Rhode Island					(2)	(2)	(2)	(2)
Tennessee	104,808	536,821	103,791	457,489	122,312	612,783	113,134	606,398
Utah	84,865	(1)	25,097	(1)	197,183	(1)	216,503	(1)
Virginia	316,754	1,413,595	247,734	1,052,016				
Washington	30,701	246,769	18,747	151,902	40,570	283,990	40,755	285,285
West Virginia	527,142	2,161,310	431,419	1,543,933	1,396,235	4,679,048	1,367,181	3,761,460
Wisconsin					(2)	(2)	(2)	(2)
Combined States	232,756	1,317,756	76,809	406,691	1,447,830	10,624,596	1,413,353	9,682,047
Undistributed		2,032,296		1,191,159		16,253,681		16,091,743
	7,207,417	30,276,775	4,492,803	16,318,556	43,884,725	232,043,803	48,313,025	236,515,204

¹ Included under "Undistributed."² Included under "Combined States."*Coke produced in the United States, 1927 and 1928, by months, in short tons*

Month	1927			1928		
	Beehive	By-product	Total	Beehive	By-product	Total
January	810,000	3,706,000	4,516,000	385,000	3,906,000	4,291,000
February	776,000	3,429,000	4,205,000	400,000	3,731,000	4,131,000
March	916,000	3,876,000	4,792,000	459,000	4,074,000	4,533,000
April	802,000	3,705,000	4,507,000	387,000	3,934,000	4,321,000
May	648,000	3,785,000	4,433,000	386,000	4,109,000	4,495,000
June	596,000	3,594,000	4,190,000	311,000	3,970,000	4,281,000
July	480,000	3,655,000	4,135,000	280,000	3,920,000	4,200,000
August	500,000	3,677,000	4,177,000	297,000	4,004,000	4,301,000
September	470,000	3,601,000	4,071,000	322,000	3,967,000	4,289,000
October	431,000	3,717,000	4,148,000	431,000	4,229,000	4,660,000
November	390,000	3,497,000	3,887,000	427,000	4,142,000	4,569,000
December	388,000	3,643,000	4,031,000	408,000	4,327,000	4,735,000
	7,207,000	43,885,000	51,092,000	4,493,000	48,313,000	52,806,000

Coke imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Short tons	Value	Short tons	Value
1919	16,486	\$140,653	716,956	\$5,128,119
1920	41,143	403,175	919,802	9,993,665
1921	30,990	336,394	306,755	2,760,939
1922	94,228	802,987	511,541	4,319,538
1923	95,002	862,596	1,237,342	11,889,897
1924	82,833	795,477	659,350	4,926,478
1925	201,579	1,609,474	953,812	6,871,962
1926	284,548	2,174,350	987,260	6,979,896
1927	168,859	1,371,568	806,664	5,430,704
1928	147,701	1,132,855	1,097,666	7,394,531

By-products from coke-oven operations in the United States, 1927 and 1928

[Exclusive of screenings and breeze]

Product	Produced	Sold	
		Quantity	Value
1927			
Tar.....gallons.....	546,859,205	305,898,176	\$16,095,478
Ammonia:			
Sulphate.....pounds.....	1,216,141,460	1,267,753,969	24,802,926
Ammonia liquor (NH ₃ content).....do.....	54,694,723	53,994,327	2,580,342
Sulphate equivalent of all forms.....do.....	(1,434,920,352)	(1,483,731,277)	27,383,268
Gas:			
Distributed through city mains.....M cu. ft. }	1 700,894,799	106,910,108	36,249,081
Used in steel or affiliated plant.....do.....		244,969,339	26,580,340
Used under boilers, etc.....do.....		25,848,762	1,866,342
Sold for industrial use.....do.....		30,661,148	5,396,405
			70,092,168
Light oil and derivatives:			
Crude light oil.....gallons.....	² 164,488,233	9,265,948	1,077,957
Benzol, crude and refined.....do.....	22,007,760	21,193,807	4,371,519
Motor benzol.....do.....	86,995,343	86,802,745	14,629,999
Toluol, crude and refined.....do.....	12,093,590	11,784,984	3,999,820
Solvent naphtha and xylol.....do.....	4,979,736	3,661,970	926,787
Other light-oil products.....do.....	3,155,031	1,393,876	147,017
			25,153,099
Naphthalene, crude.....pounds.....	8,302,845	7,848,224	86,078
Other products.....pounds.....			93,791
			138,903,882
1928			
Tar.....gallons.....	631,844,767	332,150,270	17,544,797
Ammonia:			
Sulphate.....pounds.....	1,387,895,214	1,318,369,804	24,826,744
Ammonia liquor (NH ₃ content).....do.....	52,469,456	52,584,975	2,513,312
Sulphate equivalent of all forms.....do.....	(1,597,773,038)	(1,528,709,704)	27,340,056
Gas:			
Distributed through city mains.....M cu. ft. }	1 775,512,939	125,131,465	39,935,641
Used in steel or affiliated plant.....do.....		286,132,946	31,509,424
Used under boilers, etc.....do.....		18,620,112	1,132,547
Sold for industrial use.....do.....		24,588,049	3,921,245
			76,498,857
Light oil and derivatives:			
Crude light oil.....gallons.....	² 188,597,956	10,334,813	1,158,846
Benzol, crude and refined.....do.....	21,451,748	21,452,973	4,215,752
Motor benzol.....do.....	103,051,900	102,935,995	16,832,646
Toluol, crude and refined.....do.....	16,097,856	16,181,650	5,513,624
Solvent naphtha and xylol.....do.....	5,587,370	4,471,141	1,047,095
Other light-oil products.....do.....	3,114,531	1,388,106	111,844
			28,879,807
Naphthalene, crude and refined.....pounds.....	12,182,143	10,937,429	135,693
Other products.....pounds.....			910,318
			151,309,528

¹ Inclusive of gas wasted and gas used for heating retorts.² Of the crude light oil 161,072,729 gallons in 1927 and 182,998,384 gallons in 1928 was refined on the premises to make the derived products listed.

COLUMBITE

[See Tantalum]

COPPER ¹*Summary of statistics of the copper industry in the United States, 1926-1928*

	1926	1927	1928
Production of copper:			
Smelter output from domestic ores.....pounds..	1,739,622,094	1,684,040,983	1,825,900,393
Mine production.....do.....	1,725,275,931	1,649,959,370	1,809,796,907
Refinery production of new copper—			
Electrolytic.....do.....	1,553,041,424	1,520,076,181	1,607,120,026
Lake.....do.....	172,372,304	195,135,199	179,104,311
Casting.....do.....	5,883,433	3,740,819	5,573,050
Total domestic.....do.....	1,731,297,161	1,718,952,199	1,791,797,387
Total domestic and foreign.....do.....	2,322,485,376	2,325,763,709	2,487,607,779
Total new and old copper.....do.....	3,282,000,000	3,306,000,000	3,560,000,000
Ore produced:			
Copper ore.....short tons..	57,181,894	56,725,460	62,097,132
Average yield of copper.....per cent..	1.46	1.41	1.41
Copper-lead and copper-lead-zinc ores.....short tons..	282,015	418,601	351,131
Average price per pound.....cents..	14.0	13.1	14.4
General imports (unmanufactured).....pounds..	779,441,803	718,322,990	787,073,640
Exports of metallic copper ² do.....	960,220,112	1,069,493,121	1,121,186,640
Withdrawn from total supply on domestic account:			
Total new copper.....pounds..	1,570,136,207	1,422,959,219	1,608,538,878
Total new and old copper.....do.....	2,530,000,000	2,403,000,000	2,681,000,000
Stocks at end of year:			
Refined copper.....do.....	146,000,000	171,000,000	114,000,000
Blister and material in solution.....do.....	455,000,000	401,000,000	423,000,000
World production (smelter).....do.....	3,216,543,000	3,348,821,000	3,756,676,000
Value of smelter production from domestic ores.....	\$243,547,000	\$220,609,000	\$262,930,000

¹ For prices of copper, see statement on p. A8.² Total exports of copper, exclusive of ore, concentrates, composition metal, and unrefined copper for which figures are not separable from those for ore and concentrates; also exclusive of "Other manufactures of copper" for which figures for quantity are not recorded.*Copper produced in the United States from domestic ores, 1919-1928*

[Smelter output, in pounds fine]

Year	Pounds	Value	Year	Pounds	Value
1919.....	1,286,419,329	\$239,274,000	1924.....	1,634,249,192	\$214,057,000
1920.....	1,209,061,040	222,467,000	1925.....	1,674,869,886	237,832,000
1921.....	505,586,098	65,221,000	1926.....	1,739,622,094	243,547,000
1922.....	950,285,947	128,289,000	1927.....	1,684,040,983	220,609,000
1923.....	1,434,999,962	210,945,000	1928.....	1,825,900,393	262,930,000

Copper produced in the United States from domestic ores, 1924-1928, by States

[Smelter output, in pounds fine]

State	1924	1925	1926	1927	1928
Alaska.....	77,053,492	72,204,166	67,631,846	56,489,214	40,541,968
Arizona.....	672,365,115	722,653,457	729,324,537	681,168,117	735,632,406
California.....	49,433,716	46,943,604	30,442,961	25,802,603	24,707,992
Colorado.....	4,158,612	3,163,211	4,657,591	8,006,801	10,262,083
Idaho.....	3,148,519	3,144,064	1,171,262	1,811,103	2,336,654
Michigan.....	145,333,227	138,029,764	174,778,884	195,135,199	179,104,311
Missouri.....	184,947	12,114	54,378	5,041	930
Montana.....	249,322,394	270,604,676	257,271,936	225,208,853	251,046,415
Nevada.....	77,281,479	77,137,563	109,041,769	118,298,342	159,332,977
New Mexico.....	78,145,629	76,467,245	82,848,096	79,761,222	92,777,233
North Carolina.....			1,468,746	5,362,041	8,207,000
Oregon.....	716,656	126,107	279,223	484,652	375,049
Pennsylvania.....	1,263,535	562,240	495,698	2,149,182	5,013,868
Tennessee.....	18,251,996	19,789,234	18,601,586	14,498,951	16,374,261
Texas.....	302	785	17,102	25,460	432,968
Utah.....	256,531,349	242,730,986	259,649,158	267,705,597	298,375,465
Vermont.....			446,323	238,143	
Washington.....	978,647	1,184,807	1,336,617	1,766,953	1,197,340
Wyoming.....		331			2,575
Undistributed.....	79,577	115,532	104,381	123,509	178,898
	1,634,249,192	1,674,869,886	1,739,622,094	1,684,040,983	1,825,900,393

Primary and secondary copper produced by regular refining plants in the United States and imported, 1924-1928, in pounds

	1924	1925	1926	1927	1928
Primary:					
Domestic ¹ —					
Electrolytic.....	1, 499, 223, 447	1, 533, 995, 439	1, 553, 041, 424	1, 520, 076, 181	1, 607, 120, 026
Lake.....	145, 333, 227	138, 029, 764	172, 372, 304	195, 135, 199	179, 104, 311
Casting.....	29, 657, 925	10, 870, 144	5, 883, 433	3, 740, 819	5, 573, 050
	1, 674, 214, 599	1, 682, 895, 347	1, 731, 297, 161	1, 718, 952, 199	1, 791, 797, 387
Foreign ¹ —					
Electrolytic.....	577, 100, 034	516, 632, 530	588, 932, 788	605, 748, 329	693, 787, 036
Casting and best select.....	8, 761, 377	5, 045, 947	2, 255, 427	1, 063, 181	2, 023, 356
Total refinery production of new copper...	2, 260, 076, 010	2, 204, 573, 824	2, 322, 485, 376	2, 325, 763, 709	2, 487, 607, 779
Imports of refined copper...	145, 909, 968	99, 773, 546	170, 565, 766	103, 279, 082	84, 730, 630
Total new refined copper made available...	2, 405, 985, 978	2, 304, 347, 370	2, 493, 051, 142	2, 429, 042, 791	2, 572, 338, 409
Secondary:					
Electrolytic.....	104, 281, 430	140, 349, 541	163, 061, 465	168, 766, 566	191, 323, 029
Casting.....	50, 536, 678	58, 010, 653	62, 056, 941	41, 102, 000	41, 322, 776
	154, 818, 108	198, 360, 194	225, 118, 406	209, 868, 566	232, 645, 805
	2, 560, 804, 086	2, 502, 707, 564	2, 718, 169, 548	2, 638, 911, 357	2, 804, 984, 214

¹ The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

In addition to their output of metallic copper, the regular refining companies produced bluestone having copper content as follows: 1924, 5,766,000 pounds; 1925, 6,754,000 pounds; 1926, 8,498,000 pounds; 1927, 9,180,000 pounds; 1928, 11,326,000 pounds.

Stocks of copper in the United States, January 1, 1920-1929, in pounds

Year	Refined copper	Blister and material in process of refining	Year	Refined copper	Blister and material in process of refining
1920.....	631, 000, 000	273, 000, 000	1925.....	243, 000, 000	393, 000, 000
1921.....	659, 000, 000	465, 000, 000	1926.....	124, 000, 000	432, 000, 000
1922.....	459, 000, 000	283, 000, 000	1927.....	146, 000, 000	455, 000, 000
1923.....	216, 000, 000	361, 000, 000	1928.....	171, 000, 000	401, 000, 000
1924.....	264, 000, 000	432, 000, 000	1929.....	114, 000, 000	423, 000, 000

New refined copper withdrawn from total year's supply on domestic account in the United States, 1924-1928, in pounds

	1924	1925	1926	1927	1928
Total supply of new copper...	2, 405, 985, 978	2, 304, 347, 370	2, 493, 051, 142	2, 429, 042, 791	2, 572, 338, 409
Stocks at beginning of year...	264, 000, 000	243, 000, 000	124, 000, 000	146, 000, 000	171, 000, 000
Total available supply...	2, 669, 985, 978	2, 547, 347, 370	2, 617, 051, 142	2, 575, 042, 791	2, 743, 338, 409
Copper exported.....	1, 072, 243, 414	1, 022, 335, 279	900, 914, 935	981, 083, 572	1, 020, 799, 531
Stocks at end of year.....	243, 000, 000	124, 000, 000	146, 000, 000	171, 000, 000	114, 000, 000
	1, 315, 243, 414	1, 146, 335, 279	1, 046, 914, 935	1, 152, 083, 572	1, 134, 799, 531
Withdrawn on domestic account.....	1, 354, 742, 564	1, 401, 012, 091	1, 570, 136, 207	1, 422, 959, 219	1, 608, 538, 878

Copper (in unmanufactured form) imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	437,570,497	\$88,751,115	1924.....	765,685,592	\$95,608,460
1920.....	480,297,985	88,782,609	1925.....	651,005,759	83,948,686
1921.....	350,582,746	45,660,326	1926.....	779,437,231	99,679,746
1922.....	542,932,525	65,786,811	1927.....	718,322,990	84,769,961
1923.....	671,929,223	95,398,681	1928.....	787,081,063	97,965,353

Copper (unmanufactured) imported into the United States, 1927 and 1928, in pounds

[General imports]

Country	Ore (copper content)	Concentrates (copper content)	Matte and regulus (copper content)	Unrefined black blister and converter copper in pigs or converter bars	Refined in ingots, plates, or bars	Old and scrap fit only for remanufacture	Composition metal, copper chief value
1927							
Africa:							
Belgian Congo	1,010			114,482,007			
Union of South Africa.....				2,697,436	165		
Australia.....	307,397						
Canada.....	40,496,764	10,537,756		51,480,389	825,843	5,639,111	
Chile.....	35,217,293	5,548,687	14,970	63,697,974	100,839,354	272,738	
Cuba.....	4,263,985	25,108,017		241,920	35,496	628,987	
France.....	123,081	89,808		123,309			300
Germany.....	342,342	115,785	68,896		557,701	165,932	57,342
Mexico.....	6,650,973	25,286,667	1,210,431	82,984,970		132,337	
Peru.....	1,989,847	19,112	84,896	101,870,992		73,744	
Spain.....	8,463,703						
United Kingdom.....	78,848	121,692	14,275	19,509,068	1,009,323	72,853	
Venezuela.....	136,572	1,364,366				37,380	
Other.....	1,226,558	910		1,505,918	11,200	454,530	
Total value.....	\$99,328,373	\$68,192,800	\$1,393,468	\$438,594,013	\$103,279,082	\$7,477,612	\$57,642
	\$10,757,297	\$8,106,626	\$131,092	\$51,954,453	\$13,105,086	\$698,494	\$14,573
1928							
Africa:							
Belgian Congo				113,999,871			
British East				4,701,706			
Union of South	721,110	54,160		2,868,195		31,200	
Portuguese (Mozambique).....				13,906,012			
Australia.....	315,987			54,000			
Canada.....	48,084,775	1,040,490		95,681,502	150,124	7,883,497	17,713
Chile.....	34,275,132	328,328	12,437	95,767,272	83,733,020	15,230	
Cuba.....	2,740,181	11,438,200				550,618	
France.....	275,790	128,269	40,842	52,120	33,506	27,537	
Germany.....	300,986	78,833		170,441	769,180	92,179	164,563
Mexico.....	7,756,953	26,296,272	2,536,922	95,691,530		87,887	
Peru.....	927,218		50,283	115,595,856			
Spain.....	9,054,542	59,387		279,639			
United Kingdom.....	202,217			3,668,875		1,383,251	
Venezuela.....						41,978	
Other.....	1,536,831	48,610		753,121	44,800	519,130	33,332
Total value.....	\$106,191,722	\$39,472,519	\$2,640,484	\$543,190,140	\$84,730,630	\$10,632,507	\$215,608
	\$11,589,484	\$4,860,595	\$284,656	\$67,595,061	\$12,634,463	\$969,382	\$31,718

Copper exported from the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	516,627,775	\$117,417,055	1924.....	1,116,915,484	\$156,645,684
1920.....	624,053,701	127,468,606	1925.....	1,084,208,532	161,165,820
1921.....	628,804,750	85,351,928	1926 ¹	965,685,264	139,853,365
1922.....	743,039,888	103,874,007	1927 ¹	1,076,729,246	149,114,730
1923.....	829,314,002	129,219,975	1928 ¹	1,125,019,417	168,525,383

¹ Exclusive of "Other manufactures of copper," valued at \$1,350,391 in 1926, at \$1,098,886 in 1927, and at \$1,296,996 in 1928, for which quantity is not recorded.

Copper exported from the United States, 1927 and 1928, in pounds

Country	Ore, concentrates, composition metal, and unrefined copper (copper content)	Refined		Old and scrap	Pipes and tubes	Plates and sheets	Wire (except insulated)	Insulated wire and cable	Other manufactures of copper
		Bars, ingots, or other forms	Rods						
1927									
Belgium.....	5, 758, 076	89, 498, 171	639, 590	246, 572	35	244, 134	125	17, 205	
Canada.....	30, 003	15, 445, 902	16, 639, 221	5, 354, 847	2, 014, 079	1, 801, 415	536, 436	1, 692, 577	
China.....	-----	5, 639, 979	-----	6, 500	1, 121	26, 032	6, 437	94, 700	
Denmark.....	-----	1, 000, 366	4, 486, 234	-----	-----	2, 192	2, 570	39, 044	
France.....	-----	111, 937, 106	764, 249	1, 155, 315	58, 381	347, 380	25, 206	140, 880	
Germany.....	-----	221, 841, 647	-----	25, 137, 084	-----	1, 580, 624	1, 156, 448	486, 778	
India (British).....	-----	5, 994, 354	109, 936	369, 530	-----	28, 862	374, 332	489, 209	
Italy.....	-----	86, 270, 218	-----	325, 490	-----	561, 770	769	3, 932	
Japan.....	165	24, 475, 434	-----	5, 555, 025	335	4, 680	219, 143	136, 589	
Netherlands.....	758, 792	104, 600, 674	2, 115, 711	4, 188, 862	661	919, 921	71, 166	55, 194	
Norway.....	142, 676	1, 436, 616	1, 854, 744	-----	-----	1, 784	36, 396	10, 573	
Spain.....	7, 548	3, 769, 759	7, 295	666, 679	94	-----	50, 256	56, 882	
Sweden.....	-----	21, 875, 271	-----	157, 060	-----	-----	1, 048	10, 936	
Switzerland.....	-----	280, 386	-----	-----	-----	-----	2, 071	7, 059	
United Kingdom.....	536, 775	182, 565, 499	23, 032, 771	2, 158, 968	20, 223	606, 133	233, 785	1, 205, 595	
Other.....	2, 090	45, 814, 761	8, 997, 678	99, 346	1, 043, 536	948, 920	7, 574, 367	18, 043, 151	
Total value.....	7, 236, 125 \$784, 617	922, 466, 143 \$125, 378, 316	58, 317, 429 \$ 870, 322	45, 118, 278 \$8, 127, 889	3, 138, 565 \$776, 739	7, 073, 847 \$1, 321, 445	10, 288, 555 \$1, 689, 316	22, 490, 304 \$5, 166, 086	(1) \$1, 098, 886
1928									
Belgium.....	-----	77, 431, 816	2, 678, 650	333, 078	249	420	4, 438	39, 410	
Canada.....	-----	21, 161, 896	25, 033, 498	5, 015, 354	2, 369, 599	2, 420, 475	1, 743, 056	2, 664, 428	
China.....	-----	5, 892, 177	-----	40, 964	-----	33, 439	250, 513	211, 136	
Denmark.....	-----	1, 998, 300	1, 457, 494	3, 715, 460	3, 450	112, 366	224, 789	52, 734	
France.....	22, 415	171, 440, 871	1, 166, 340	23, 581, 476	221	229	120, 287	114, 233	
Germany.....	2, 041, 492	206, 549, 919	33, 584	449, 130	10, 267	504, 061	2, 552, 020	43, 840	
India (British).....	-----	2, 449, 157	324, 209	262, 123	-----	279, 695	525, 157	293, 034	
Italy.....	1, 345, 580	116, 547, 931	224, 397	10, 421, 220	440	440	533, 684	447, 423	
Japan.....	-----	32, 395, 333	47, 572	7, 972, 816	5, 762	404, 036	508, 628	102, 699	
Netherlands.....	154, 116	64, 526, 417	2, 525, 531	7, 972, 816	-----	1, 959	20, 730	196, 355	
Norway.....	72, 527	3, 405, 799	2, 802, 047	41, 219	1, 260	650	141, 070	122, 305	
Spain.....	-----	3, 321, 076	2, 701	1, 312, 277	-----	-----	1, 956	13, 693	
Sweden.....	-----	28, 704, 670	226, 367	-----	-----	-----	1, 438	4, 988	
Switzerland.....	-----	705, 289	-----	-----	-----	-----	193, 159	1, 015, 801	
United Kingdom.....	41, 754	185, 816, 840	26, 954, 825	2, 082, 591	25, 448	724, 996	8, 628, 871	14, 308, 296	
Other.....	800	28, 126, 947	8, 047, 860	238, 847	1, 137, 316	1, 258, 504	-----	-----	
Total value.....	3, 832, 777 \$508, 112	949, 474, 456 \$140, 339, 589	71, 325, 075 \$11, 066, 251	55, 466, 555 \$9, 994, 196	3, 554, 241 \$901, 336	6, 039, 457 \$1, 275, 305	15, 675, 751 \$2, 623, 986	19, 651, 105 \$4, 816, 608	(1) \$1, 296, 996

1 Figures for quantity not recorded.

CORUNDUM

[See Abrasive materials]

CRYOLITE

No natural cryolite is produced in the United States, the entire supply in this country being imported from Greenland. Artificial cryolite is produced by electrochemical processes.

Cryolite imported for consumption in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919.....	2, 131	\$106, 956	1924.....	6, 320	\$320, 670
1920.....	3, 864	193, 638	1925.....	9, 844	690, 651
1921.....	3, 460	295, 186	1926.....	7, 599	557, 598
1922.....	3, 899	196, 302	1927.....	5, 064	410, 876
1923.....	6, 375	319, 959	1928.....	6, 906	529, 176

DIATOMITE (INFUSORIAL EARTH)

[See Abrasive materials]

EMERY

[See Abrasive materials]

FELDSPAR

Crude feldspar sold or used by producers in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919.....	63, 441	\$347, 992	1924.....	204, 772	\$1, 509, 339
1920.....	135, 551	851, 123	1925.....	185, 706	1, 315, 654
1921.....	91, 865	617, 652	1926.....	209, 989	1, 607, 101
1922.....	117, 127	844, 568	1927.....	202, 497	1, 424, 755
1923.....	145, 004	1, 057, 595	1928.....	210, 811	1, 418, 975

The foreign trade of the United States in feldspar is small and limited largely to importing from Canada. Imports have been as follows: 1928, 27,857 long tons of crude feldspar, valued at \$224,920; 1927, 27,424 tons, \$206,856; 1926, 29,941 tons, \$251,896; 1925, 24,994 tons, \$203,524; 1924, 35,139 tons, \$284,716; 1923, 24,271 tons, \$184,924. Prior to September 22, 1922, imports of feldspar were not specifically classified in the official records and are therefore unknown. From that date to the end of the year the imports amounted to 7,549 long tons of crude, valued at \$60,111, and 37 long tons of crushed or ground, valued at \$538. No imports of crushed or ground feldspar were recorded from 1923 to 1925 but 36 long tons, valued at \$1,743, was imported in 1926; 250 pounds, valued at \$3, in 1927; and 49 long tons, valued at \$1,091, in 1928.

There is no record of exports of feldspar, and if any feldspar is exported the quantity is doubtless negligible.

FERRO-ALLOYS

Ferro-alloys shipped from furnaces in the United States, 1919-1928, in long tons

Year	Ferromanganese	Spiegeleisen	Other varieties	Total	
				Quantity	Value
1919.....	198,255	90,855	130,528	419,638	\$53,730,964
1920.....	276,594	103,672	232,542	612,808	77,519,367
1921.....	111,374	69,230	68,023	248,627	21,697,785
1922.....	161,612	70,253	191,415	423,280	28,259,004
1923.....	226,365	134,086	219,366	579,817	49,877,231
1924.....	232,821	76,179	188,244	497,244	43,249,948
1925.....	254,005	95,890	266,327	616,222	53,048,100
1926.....	330,070	82,982	276,206	689,258	61,368,407
1927.....	291,056	80,892	274,801	646,749	55,163,574
1928.....	310,122	116,911	367,662	794,695	66,578,039

Ferro-alloys shipped from furnaces in the United States, 1927 and 1928

Variety of alloy	1927		1928	
	Long tons	Value	Long tons	Value
Ferromanganese.....	291,056	\$27,243,489	310,122	\$29,199,990
Silicomanganese.....	3,173	301,321	(1)	(1)
Silicospiegeleisen.....			(1)	(1)
Spiegeleisen.....	80,892	1,986,188	116,911	2,802,108
Ferrosilicon (7 per cent or more silicon).....	232,576	11,903,782	310,770	15,199,746
Ferromolybdenum and calcium-molybdenum compounds..	(1)	(1)	(1)	(1)
Ferrotungsten.....	1,289	2,185,788	1,975	3,195,690
Ferrovandium.....	1,467	3,939,067	1,895	5,085,759
Other varieties ¹	36,296	7,603,939	53,022	11,094,746
	646,749	55,163,574	794,695	66,578,039

¹ Included under "Other varieties."

² 1927: Ferrochromium, ferromolybdenum and calcium-molybdenum compounds, ferrophosphorus, ferrotitanium, ferrozirconium, and zirconium-ferrosilicon; 1928: Ferrochromium, ferromolybdenum and calcium-molybdenum compounds, ferrophosphorus, ferrotitanium, ferrozirconium, silicomanganese, silicospiegeleisen, and zirconium-ferrosilicon.

Value of ferro-alloys imported for consumption in the United States, 1919-1928

1919.....	\$5,384,693	1924.....	\$5,509,020
1920.....	10,397,896	1925.....	7,133,618
1921.....	1,576,131	1926.....	6,303,757
1922.....	7,789,632	1927.....	4,752,552
1923.....	9,879,433	1928.....	6,158,449

Ferro-alloys imported for consumption in the United States, 1927 and 1928

Variety of alloy	1927		1928	
	Long tons	Value	Long tons	Value
Ferromanganese (manganese content).....	36,400	\$3,553,465	48,844	\$4,899,374
Spiegeleisen.....	7,529	220,979	5,260	147,406
Ferrochrome and chromium:				
Ferrochrome—				
Containing 3 per cent or more carbon (chromium content).....	1	143	69	15,344
Containing less than 3 per cent carbon.....	143	32,096	611	170,069
Chrome or chromium metal.....	10	2,879	10	2,508
Ferrosilicon (silicon content).....	7,347	923,158	4,697	649,739
Molybdenum and ferromolybdenum (molybdenum content).....	1	5,712	(1)	1,385
Titanium and ferrotitanium.....	8	3,310	17	6,067
Tungsten and ferrotungsten (tungsten content).....	12	10,482	50	50,849
Ferrovandium.....	(2)	328	107	215,708
		4,752,552		6,158,449

¹ 576 pounds.

² 1,058 pounds.

Ferro-alloys exported from the United States, 1919-1928

Variety of alloy	1919		1920		1921		1922		1923	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Ferromanganese.....	2, 999	\$445, 840	3, 454	\$642, 570	690	\$100, 474	1, 107	\$76, 822	4, 295	151, 224
Spiegeleisen.....	(1)	(1)	(1)	(1)	(1)	(1)	289	7, 740		
Ferrochrome and chrome metal.....	(1)	(1)	(1)	(1)	(1)	(1)	23	1, 941	(2)	(2)
Ferrosilicon.....	1, 544	145, 310	632	41, 057	368	20, 204	689	30, 939	814	31, 154
Tungsten and ferrotungsten.....	17	113, 276	2	5, 913	-----	-----	(3)	43, 219	4 2	122, 906
Ferrovanadium.....	29	95, 560	173	705, 385	98	424, 886	22	69, 279	23	64, 713

Variety of alloy	1924		1925		1926		1927		1928	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Ferromanganese.....	3, 165	\$92, 421	5, 496	\$160, 568	693	\$44, 111	1, 641	\$61, 793	9, 440	\$232, 990
Spiegeleisen.....	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Ferrochrome and chrome metal.....	775	29, 214	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Ferrosilicon.....	2	114, 775	6	143, 987	13	155, 653	9	164, 917	7	123, 354
Tungsten and ferrotungsten (including tungsten wire).....	25	81, 016	46	106, 754	(2)	(2)	(2)	(2)	(2)	(2)
Ferrovanadium.....										

¹ Not separately classified prior to 1922.² 1,009 pounds.² Not separately recorded.⁴ Includes tungsten wire.

FLUORSPAR

Fluorspar shipped from mines in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	138, 290	\$3, 525, 574	1924.....	124, 979	\$2, 451, 131
1920.....	186, 778	4, 718, 547	1925.....	113, 669	2, 052, 342
1921.....	34, 960	724, 094	1926.....	128, 657	2, 341, 277
1922.....	141, 596	2, 531, 165	1927.....	112, 546	2, 034, 728
1923.....	121, 188	2, 505, 819	1928.....	140, 490	2, 656, 554

Fluorspar shipped from mines in the United States, 1926-1928, by States

State	1926		1927		1928	
	Short tons	Value	Short tons	Value	Short tons	Value
Illinois.....	53, 734	\$1, 012, 879	46, 006	\$863, 909	65, 884	\$1, 154, 983
Kentucky.....	62, 494	1, 167, 129	57, 495	1, 040, 338	69, 747	1, 426, 766
Colorado.....	10, 440	161, 269	6, 432	130, 481	1, 815	74, 805
New Mexico.....	1, 989		2, 613		2, 589	
Nevada.....					455	
	128, 657	2, 341, 277	112, 546	2, 034, 728	140, 490	2, 656, 554

Fluorspar imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	6, 943	\$107, 631	1924.....	50, 821	\$551, 842
1920.....	24, 612	265, 630	1925.....	48, 770	469, 540
1921.....	6, 229	69, 306	1926.....	75, 626	746, 479
1922.....	33, 108	299, 188	1927.....	71, 242	594, 082
1923.....	41, 884	429, 696	1928.....	47, 450	409, 841

No exports of fluorspar have been reported by Bureau of Foreign and Domestic Commerce. Producers have reported exports, as follows:

Fluorspar reported by producers as exported from the United States, 1920-1928

Year	Short tons	Value	Year	Short tons	Value
1920.....	2,764	\$65,475	1925.....	1,055	\$17,574
1921.....			1926.....	2,132	34,915
1922.....	2,296	40,966	1927.....	385	7,507
1923.....	1,144	25,312	1928.....	398	6,586
1924.....	617	14,489			

FULLER'S EARTH

Fuller's earth sold or used by producers in the United States, 1919-1928

Year	Number of operators	Short tons	Value	Year	Number of operators	Short tons	Value
1919.....	10	106,145	\$1,998,829	1924.....	13	177,994	\$2,632,342
1920.....	12	128,487	2,506,189	1925.....	14	206,574	2,923,965
1921.....	12	105,609	1,973,848	1926.....	14	234,152	3,356,482
1922.....	15	138,944	2,289,719	1927.....	16	264,478	3,767,038
1923.....	15	149,134	2,247,523	1928.....	17	287,012	3,895,991

Fuller's earth imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	13,873	\$189,711	1924.....	7,302	\$92,488
1920.....	19,015	221,893	1925.....	8,015	111,295
1921.....	9,744	119,415	1926.....	9,098	123,674
1922.....	10,569	135,695	1927.....	7,580	109,281
1923.....	8,547	113,944	1928.....	7,593	132,003

Exports of fuller's earth are not reported separately.

GARNET (ABRASIVE)

[See Abrasive materials]

GAS (NATURAL)

Natural gas produced in the United States and delivered to consumers, 1919-1928

[Value at point of consumption]

Year	M cubic feet	Value	Year	M cubic feet	Value
1919.....	745,916,000	\$160,888,000	1924.....	1,141,521,000	\$253,856,000
1920.....	798,210,000	196,194,000	1925.....	1,188,571,000	265,271,000
1921.....	662,052,000	174,617,000	1926.....	1,313,019,000	300,168,000
1922.....	762,546,000	221,535,000	1927.....	1,445,428,000	317,930,000
1923.....	1,006,976,000	240,001,000	1928.....	1,568,139,000	363,726,000

*Natural gas produced in the United States and delivered to consumers, 1927 and 1928,
by States*

[Value at point of consumption]

State	1927		1928	
	M cubic feet	Value	M cubic feet	Value
Arkansas.....	30,450,000	\$4,281,000	20,235,000	\$3,562,000
California.....	212,364,000	50,946,000	246,215,000	56,695,000
Colorado.....	1,725,400	290,000	2,931,000	786,000
Illinois.....	3,741,000	764,000	3,051,000	360,000
Indiana.....	1,124,000	509,000	1,290,000	639,000
Kansas.....	42,646,000	12,833,000	45,644,000	14,144,000
Kentucky.....	10,206,000	3,277,000	15,383,000	5,349,000
Louisiana.....	186,961,000	12,158,000	227,821,000	20,279,000
Michigan.....	600	300	469,000	149,000
Missouri.....	300	200	360,000	217,000
Montana.....	4,253,100	716,400	6,277,000	1,446,000
New Mexico.....	1,019,000	48,500	838,000	66,000
New York.....	5,908,000	3,841,000	7,224,000	4,827,000
North Dakota.....	200	100	(1)	(1)
Ohio.....	51,381,000	28,881,000	56,341,000	32,090,000
Oklahoma.....	326,864,000	41,391,000	320,861,000	47,476,000
Pennsylvania.....	105,709,500	49,135,000	99,466,000	48,432,000
South Dakota.....	92,000	136,500	54,000	53,000
Tennessee.....	9,000	2,200	(1)	(1)
Texas.....	254,063,000	37,424,800	301,990,000	51,316,000
Utah.....	(1)	(1)	1,105,000	22,000
West Virginia.....	162,375,000	67,994,000	163,018,000	72,265,000
Wyoming.....	43,581,600	3,269,800	47,490,000	3,527,000
Other ¹	954,300	31,200	76,000	26,000
	1,445,428,000	317,930,000	1,568,139,000	363,726,000

¹ Included under "Other."

² 1927: Alaska, Mississippi, and Utah; 1928: Alaska, Mississippi, North Dakota, and Tennessee.

GASOLINE FROM NATURAL GAS

Natural gasoline produced in the United States, 1919-1928

Year	Raw (unblended) gasoline produced		Natural gas treated (estimated) (M cubic feet)
	Gallons	Value at plant	
1919.....	351,535,026	\$64,196,763	480,404,000
1920.....	384,743,922	71,788,122	496,431,000
1921.....	449,934,402	61,815,258	465,097,000
1922.....	505,832,000	72,711,063	545,139,000
1923.....	816,226,000	77,268,000	875,711,000
1924.....	933,861,000	82,233,000	1,016,276,000
1925.....	1,127,470,000	120,383,000	1,040,390,000
1926.....	1,363,090,000	136,412,000	1,206,300,000
1927.....	1,641,144,000	118,688,000	1,341,248,000
1928.....	1,814,034,000	138,944,000	1,473,434,000

Natural gasoline produced in the United States, 1927 and 1928, by States

State	1927		1928	
	Gallons	Value	Gallons	Value
Alaska.....	19,000	\$2,000	26,000	\$3,000
Arkansas.....	37,498,000	2,281,000	32,677,000	2,568,000
California.....	498,020,000	52,436,000	584,111,000	53,885,000
Colorado.....	912,000	64,000	1,909,000	136,000
Illinois.....	8,853,000	532,000	7,817,000	585,000
Kansas.....	36,095,000	1,746,000	36,765,000	2,444,000
Kentucky.....	7,480,000	547,000	7,267,000	575,000
Louisiana.....	44,844,000	2,442,000	55,022,000	3,434,000
New Mexico.....	1,827,000	109,000	1,506,000	107,000
New York.....	449,000	38,000	392,000	45,000
Ohio.....	12,167,000	1,062,000	13,174,000	1,146,000
Oklahoma.....	548,109,000	29,114,000	619,691,000	40,959,000
Pennsylvania.....	16,744,000	1,648,000	16,571,000	1,570,000
Texas.....	320,723,000	18,347,000	324,516,000	22,492,000
West Virginia.....	64,192,000	5,421,000	69,729,000	6,220,000
Wyoming.....	43,212,000	2,890,000	42,861,000	2,775,000
	1,641,144,000	118,688,000	1,814,034,000	138,944,000

GEMS AND PRECIOUS STONES*Value of precious stones produced in the United States, 1919-1923¹*

Year	Value	Year	Value
1919.....	\$111,763	1922.....	² \$71,106
1920.....	265,205	1923 (estimate).....	65,000
1921.....	² 518,280		

¹ Canvass discontinued after 1923.² Production of diamond in Arkansas not reported.*Value of diamonds and other precious stones imported for consumption in the United States, 1919-1928*

Year	Diamonds				Other stones not set	Total, excluding pearls	Pearls
	Glazier's	Dust and bort	Rough or uncut	Cut but not set			
1919.....	\$984,381	\$1,420,442	\$20,306,758	\$64,085,610	\$5,161,639	\$91,958,830	\$11,008,973
1920.....	1,527,753	3,387,488	10,526,125	45,240,013	5,419,363	66,100,742	7,879,384
1921.....	435,872	466,345	2,207,365	26,144,323	2,778,931	32,032,836	4,492,063
1922.....	839,882	1,029,261	8,332,416	43,144,742	3,723,062	57,069,363	8,546,574
1923.....	1,065,834	228,409	7,241,550	51,975,896	5,703,279	66,214,968	7,932,929
1924.....	1,116,862	259,482	11,666,587	47,108,169	5,214,130	65,365,230	5,898,560
1925.....	1,976,640	760,476	9,492,328	49,723,818	5,228,011	67,181,273	6,734,149
1926.....	1,939,735	271,382	13,070,767	51,353,168	6,333,779	72,968,831	5,322,140
1927.....	2,148,275	62,045	11,452,439	40,714,672	4,529,350	58,906,781	6,043,162
1928.....	2,756,895	31,222	11,903,815	42,368,172	3,822,140	60,882,244	7,082,034

Domestic exports in 1922 were as follows: "Diamonds, cut but not set," 15 carats, valued at \$1,540; "other precious stones, including pearls," \$21,525. Data are not separately classified prior to 1922. For 1923 to 1928, domestic exports are recorded as "Precious stones, including pearls," as follows: 1923, \$78,967; 1924, \$146,825; 1925, \$39,823; 1926, \$64,377; 1927, \$87,291; 1928, \$72,296.

Value of foreign precious stones reexported from the United States, 1919-1928

Year	Diamonds ¹		Other precious stones ¹		Total, excluding pearls	Pearls and parts of, not strung or set
	Uncut	Cut but not set	Uncut ¹	Cut but not set		
1919.....	\$3, 238	\$25, 000	¹ \$15, 653	\$1, 783	\$45, 674	\$5, 386
1920.....			¹ 4, 604	13, 338	17, 942	8, 000
1921.....		896	¹ 14, 390	9, 353	24, 639	128
1922.....	19, 735	1, 396	¹ 7, 387	7, 546	36, 064	728
1923-1928.....	(2)	(2)	(2)	(2)	(2)	(2)

¹ Bort included under "Other precious stones—uncut."² Foreign exports for 1923 to 1925 are recorded as "Diamonds and precious stones," as follows: 1923, 535,840 carats, valued at \$27,123; 1924, 47,797 carats, \$69,230; 1925, 32,959 carats, \$26,983. Beginning 1926 they are recorded as "Precious stones and imitations," and valued as follows: 1926, \$57,304; 1927, \$62,494; 1928, \$42,513.**GOLD AND SILVER ¹***Gold and silver produced in the United States, 1919-1928*

Year	Gold		Silver	
	Troy ounces	Value	Troy ounces	Commercial value
1919.....	2, 918, 628	\$60, 333, 400	56, 682, 445	\$63, 533, 652
1920.....	2, 476, 166	51, 186, 900	55, 361, 573	60, 801, 955
1921.....	2, 422, 006	50, 067, 300	53, 052, 441	53, 052, 441
1922.....	2, 363, 075	48, 849, 100	56, 240, 048	56, 240, 048
1923.....	2, 502, 632	51, 734, 000	73, 335, 170	60, 134, 839
1924.....	2, 528, 900	52, 277, 000	65, 407, 186	43, 822, 814
1925.....	2, 411, 987	49, 860, 200	66, 155, 424	45, 911, 864
1926.....	2, 335, 042	48, 269, 600	62, 718, 746	39, 136, 497
1927.....	2, 197, 125	45, 418, 600	60, 434, 441	34, 266, 328
1928.....	2, 233, 251	46, 165, 400	58, 462, 507	31, 200, 567

¹ Gold is valued by law at \$20.67+ a troy ounce. For prices of silver, see statement on p. A8.*Gold produced in the United States, 1927 and 1928, by States ¹*

State	1927		1928	
	Troy ounces	Value ²	Troy ounces	Value ²
Alaska.....	286, 298	\$5, 918, 300	330, 604	\$6, 834, 200
Arizona.....	203, 088	4, 198, 200	189, 519	3, 917, 700
California.....	564, 981	11, 679, 200	513, 249	10, 609, 800
Colorado.....	259, 111	5, 356, 300	258, 564	5, 345, 000
Georgia.....	15	300	34	700
Idaho.....	15, 209	314, 400	20, 351	420, 700
Montana.....	56, 076	1, 159, 200	59, 661	1, 233, 300
Nevada.....	149, 445	3, 089, 300	177, 730	3, 674, 000
New Mexico.....	26, 098	539, 500	34, 961	722, 700
North Carolina.....	34	700	131	2, 700
Oregon.....	14, 425	298, 200	11, 865	245, 300
Pennsylvania.....	126	2, 600	987	20, 400
Philippine Islands.....	79, 872	1, 651, 100	88, 531	1, 830, 100
South Carolina.....			10	200
South Dakota.....	322, 681	6, 670, 400	318, 095	6, 575, 600
Tennessee.....	426	8, 800	537	11, 100
Texas.....	324	6, 700	556	11, 500
Utah.....	199, 518	4, 124, 400	211, 418	4, 370, 400
Washington.....	19, 398	401, 000	16, 414	339, 300
Wyoming.....			34	700
	2, 197, 125	45, 418, 600	2, 233, 251	46, 165, 400

¹ Figures furnished by the Bureau of the Mint.² Gold value, \$20.67 + a troy ounce.

Silver produced in the United States, 1927 and 1928, by States ¹

State	1927		1928	
	Troy ounces	Value ²	Troy ounces	Value ²
Alaska.....	606, 129	\$343, 675	486, 859	\$284, 812
Arizona.....	6, 601, 467	3, 743, 032	6, 564, 933	3, 840, 486
California.....	1, 557, 812	883, 279	1, 467, 088	858, 246
Colorado.....	3, 941, 351	2, 234, 746	4, 384, 072	2, 564, 682
Georgia.....	4	2	5	3
Idaho.....	8, 928, 619	5, 062, 527	8, 949, 716	5, 235, 584
Illinois.....	1, 500	850	2, 677	1, 566
Michigan.....	51, 742	29, 338	18, 707	10, 944
Missouri.....	87, 218	49, 453	158, 280	92, 594
Montana.....	11, 809, 765	6, 696, 137	10, 681, 675	6, 248, 780
Nevada.....	5, 372, 900	3, 046, 434	5, 312, 610	3, 107, 877
New Mexico.....	754, 878	428, 016	925, 449	541, 388
North Carolina.....	134	76	19, 141	11, 197
Oregon.....	41, 673	23, 629	31, 858	18, 637
Pennsylvania.....	2, 299	1, 303	7, 428	4, 345
Philippine Islands.....	40, 242	22, 817	36, 503	21, 354
South Dakota.....	95, 123	53, 935	91, 697	53, 643
Tennessee.....	82, 275	46, 650	75, 907	44, 406
Texas.....	942, 971	534, 664	1, 394, 665	815, 879
Utah.....	19, 353, 758	10, 973, 581	17, 749, 317	10, 383, 350
Vermont.....	938	532	13	8
Washington.....	161, 643	91, 652	103, 907	60, 786
Wyoming.....				
	60, 434, 441	34, 266, 328	58, 462, 507	34, 200, 567

¹ Figures furnished by the Bureau of the Mint.² Valued at average New York price of bar silver, as follows: 1927, 56.7 cents an ounce; 1928, 58.5 cents an ounce.*Value of gold and silver imported into and exported from the United States, 1919-1928*

Year	Gold		Silver	
	Imports	Exports	Imports	Exports
1919.....	\$76, 534, 046	\$368, 185, 248	\$89, 410, 018	\$239, 021, 051
1920.....	417, 068, 273	322, 091, 208	88, 060, 041	113, 616, 224
1921.....	691, 248, 297	23, 891, 377	63, 242, 671	51, 575, 399
1922.....	275, 169, 785	36, 874, 894	70, 806, 653	62, 807, 286
1923.....	322, 715, 812	28, 643, 417	74, 453, 530	72, 468, 789
1924.....	319, 720, 918	61, 648, 313	73, 944, 902	109, 891, 033
1925.....	128, 273, 172	262, 639, 790	64, 595, 418	99, 127, 585
1926.....	213, 504, 020	115, 707, 815	69, 595, 936	92, 257, 564
1927.....	207, 535, 195	201, 455, 100	55, 073, 917	75, 624, 780
1928.....	168, 897, 307	560, 759, 341	68, 117, 329	87, 382, 016

Value of gold and silver imported into and exported from the United States, 1927 and 1928, by classes

	Imports	Exports	Excess of—	
			Imports	Exports
1927				
Gold:				
Contained in domestic ore and base bullion		\$330, 246		\$330, 246
Contained in foreign ore and base bullion	\$18, 110, 866	2, 350	\$18, 108, 516	
Domestic bullion refined		54, 608, 475		54, 608, 475
Foreign bullion refined	87, 262, 450	21	87, 262, 429	
United States coin	71, 001, 720	146, 302, 604		75, 300, 884
Foreign coin	31, 160, 159	211, 404	30, 948, 755	
	207, 535, 195	201, 455, 100	136, 319, 700	130, 239, 605
Excess imports over exports			6, 080, 095	
Silver:				
Contained in domestic ore and base bullion		70, 157		70, 157
Contained in foreign ore and base bullion	32, 056, 952		32, 056, 952	
Domestic bullion refined	31, 795	59, 848, 110		59, 816, 315
Foreign bullion refined	20, 745, 549	13, 200, 447	7, 545, 102	
United States coin	902, 909	396, 482	506, 427	
Foreign coin	1, 336, 712	2, 109, 584		772, 872
	55, 073, 917	75, 624, 780	40, 108, 481	60, 659, 344
Excess exports over imports				20, 550, 863
1928				
Gold:				
Contained in domestic ore and base bullion		268, 517		268, 517
Contained in foreign ore and base bullion	14, 499, 910		14, 499, 910	
Domestic bullion refined		411, 892, 524		411, 892, 524
Foreign bullion refined	102, 455, 023	5, 200, 226	97, 254, 797	
United States coin	47, 870, 221	143, 225, 401		95, 355, 180
Foreign coin	4, 072, 153	172, 673	3, 899, 480	
	168, 897, 307	560, 759, 341	115, 654, 187	507, 516, 221
Excess exports over imports				391, 862, 034
Silver:				
Contained in domestic ore and base bullion		51, 769		51, 769
Contained in foreign ore and base bullion	37, 331, 651		37, 331, 651	
Domestic bullion refined		64, 051, 823		64, 051, 823
Foreign bullion refined	28, 476, 770	20, 620, 905	7, 855, 865	
United States coin	1, 622, 489	225, 210	1, 397, 279	
Foreign coin	686, 419	2, 432, 309		1, 745, 890
	68, 117, 329	87, 382, 016	46, 584, 795	65, 849, 482
Excess exports over imports				19, 264, 687

GRAPHITE

Natural graphite sold or used by producers in the United States, 1919-1928

Year	Amorphous		Crystalline	
	Short tons	Value	Pounds	Value
1919	3, 379	\$47, 716	8, 086, 191	\$731, 141
1920	4, 694	49, 758	9, 632, 360	576, 444
1921	1, 842	20, 860	1, 189, 523	75, 664
1922	2, 200	(1)	1, 849, 766	85, 242
1923	4, 056	39, 560	3, 964, 900	151, 434
1924	4, 071	38, 533	1, 800, 325	48, 977
1925	3, 536	39, 640	2, 257, 250	56, 721
1926	2, 975	40, 500	4, 989, 200	178, 842
1927	2, 595	35, 850	5, 224, 400	197, 121
1928	2, 994	43, 320	5, 233, 300	253, 773

¹ Bureau of Mines not at liberty to publish value.

Graphite is manufactured at Niagara Falls, N. Y. The figures that follow are published by permission of the producing company.

Graphite manufactured at Niagara Falls, N. Y., 1919–1928, in pounds

1919-----	8, 163, 177	1924-----	10, 986, 192
1920-----	7, 399, 749	1925-----	12, 135, 655
1921-----	5, 888, 000	1926-----	21, 163, 986
1922-----	13, 031, 926	1927-----	12, 257, 239
1923-----	26, 761, 015	1928-----	(1)

¹ Bureau of Mines not at liberty to publish figures.

Graphite imported for consumption in the United States, 1919–1928, by kinds

Year	Amorphous		Crystalline chip or dust		Crystalline flake		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919-----	(1)	(1)	(1)	(1)	(1)	(1)	26, 626	\$2, 978, 096
1920-----							21, 095	1, 711, 312
1921-----							8, 183	452, 076
1922-----							12, 488	473, 046
1923-----	11, 252	\$149, 831	7, 243	\$426, 417	939	\$37, 871	19, 434	614, 119
1924-----	10, 936	113, 751	3, 998	197, 867	1, 441	87, 893	16, 375	399, 511
1925 ² -----	9, 210	143, 750	5, 904	389, 242	2, 654	293, 418	17, 768	² 826, 410
1926 ² -----	8, 250	161, 564	5, 258	433, 848	2, 658	325, 821	16, 166	² 921, 233
1927 ² -----	9, 559	146, 881	6, 116	390, 822	1, 777	186, 220	17, 452	² 723, 923
1928 ² -----	7, 699	107, 936	7, 143	452, 424	2, 727	241, 199	17, 569	² 801, 559

¹ Not separately classified prior to 1923.

² Imports of graphite crucibles were not separately classified until 1925 when 3,100 crucibles, valued at \$548, were imported; corresponding imports for 1923 were 9,513 crucibles, \$11,780; for 1927, 2,583 crucibles, \$1,812; and for 1928, 2,368 crucibles, \$1,245; weight not recorded.

Graphite exported from the United States, 1919–1928

Year	Unmanufactured graphite		Manufactures of graphite ¹	Year	Unmanufactured graphite		Manufactures of graphite ¹
	Short tons	Value			Short tons	Value	
1919-----	629	\$90, 185	\$788, 755	1924-----	1, 022	\$144, 108	\$250, 957
1920-----	607	112, 771	610, 261	1925-----	945	142, 122	337, 481
1921-----	921	95, 998	679, 359	1926-----	405	49, 235	463, 084
1922-----	569	78, 094	255, 019	1927-----	² 1, 819	² 435, 997	(2)
1923-----	908	138, 542	335, 778	1928-----	² 2, 203	² 454, 770	(2)

¹ After 1921, exclusive of crucibles, figures for which are not available.

² Classification for 1927 and 1928 reads "Graphite and manufactures, except crucibles."

GRINDSTONES AND PULPSTONES

[See Abrasive materials]

GYPSUM*Gypsum produced in the United States and sold by producers, 1919–1928*

Year	Crude produced (short tons)	Crude and calcined sold (total value)	Year	Crude produced (short tons)	Crude and calcined sold (total value)
1919-----	2, 420, 163	\$15, 727, 907	1924-----	5, 042, 629	\$42, 724, 507
1920-----	3, 129, 142	24, 533, 065	1925-----	5, 678, 302	47, 577, 240
1921-----	2, 890, 784	23, 700, 290	1926-----	5, 635, 441	46, 721, 219
1922-----	3, 779, 949	29, 361, 151	1927-----	5, 346, 888	42, 174, 454
1923-----	4, 753, 448	34, 888, 155	1928-----	5, 102, 250	32, 036, 163

Gypsum imported for consumption in the United States, 1919-1928

Year	Crude		Ground or calcined		Value of manufactured plaster of Paris	Keenes cement		Total value
	Short tons	Value	Short tons	Value		Short tons	Value	
1919.....	171,733	\$211,946	10,415	\$126,405	\$7,719	187	\$5,984	\$352,054
1920.....	282,486	397,942	14,921	179,191	10,282	202	5,338	592,753
1921.....	266,796	364,318	4,495	55,109	33,072	184	6,836	459,335
1922.....	409,475	523,939	1,774	32,651	55,116	403	9,636	621,342
1923.....	448,129	629,203	5,133	77,716	41,317	418	11,543	759,779
1924.....	519,627	724,864	5,217	70,793	48,059	539	12,042	855,758
1925.....	634,423	915,888	10,759	140,941	56,724	449	11,294	1,124,847
1926.....	824,081	1,276,131	7,149	99,058	96,355	578	15,701	1,487,245
1927.....	828,619	1,167,581	8,650	114,947	89,096	655	16,202	1,387,826
1928.....	1,028,816	1,340,920	6,907	99,833	87,314	601	13,729	1,541,796

Exports of gypsum in 1928 are recorded as follows: "Crude, crushed, or ground," 2,365 short tons, valued at \$23,764, and "plaster, calcined, and manufactures, n. e. s.," 16,423 tons, \$392,984. For 1927 and earlier years the classification read "Gypsum or plaster, crude, ground, calcined, and manufactures of," and exports were as follows: 1927, 18,429 short tons, valued at \$471,106; 1926, 19,610 tons, \$576,585; 1925, 16,798 tons, \$498,616; 1924, 10,623 tons, \$358,425; 1923, 8,815 tons, \$226,423; 1922, 7,673 tons, \$178,166. Exports are not separately classified for earlier years.

ILMENITE

[See Titanium minerals]

IRON ORE, PIG IRON, AND STEEL**IRON ORE**

[Exclusive of all domestic ore containing 5 per cent or more of manganese. For data regarding such ore see Manganese]

Iron ore mined in the United States, 1919-1928, by varieties, in long tons

Year	Hematite	Brown ore	Magnetite	Carbonate	Total
1919.....	¹ 57,719,582	¹ 1,127,397	¹ 2,118,439	-----	60,965,418
1920.....	¹ ² 63,883,523	² 1,325,661	¹ 2,391,541	3,740	67,604,465
1921.....	¹ ² 28,337,249	² 370,154	¹ 780,866	2,709	29,490,978
1922.....	² 44,888,723	² 783,582	1,452,966	3,256	47,128,527
1923.....	² 65,924,454	² 1,232,848	2,190,624	3,516	69,351,442
1924.....	² 52,102,300	² 814,159	1,347,711	3,249	54,267,419
1925.....	² 59,546,690	² 884,600	1,472,004	4,703	61,907,997
1926.....	² ³ 64,634,573	² 810,924	³ 2,175,288	2,215	67,623,000
1927.....	² ³ 58,505,543	² 743,478	³ 2,489,586	2,493	61,741,100
1928.....	³ 59,207,857	816,637	³ 2,170,804	1,790	62,197,088

¹ Some magnetite included with hematite.

² Some hematite included with brown ore.

³ Some hematite included with magnetite.

Iron ore mined in the United States, 1927 and 1928, by mining districts and varieties, in long tons

District	Hematite	Brown ore	Magnetite	Carbonate	Total
1927					
Lake Superior ¹	51,539,880				51,539,880
Birmingham.....	5,857,326	437,487			6,294,813
Chattanooga.....	89,351	70,897			160,248
Adirondack.....					
Northern New Jersey and southeastern New York.....			² 1,073,819		² 1,073,819
Other districts.....	² 1,018,986	² 235,094	1,415,767	2,493	² 2,672,340
	² 58,505,543	² 743,478	² 2,489,585	2,493	61,741,100
1928					
Lake Superior ¹	52,517,175				52,517,175
Birmingham.....	5,658,021	509,173			6,167,194
Chattanooga.....	94,134	98,372			192,506
Adirondack.....					
Northern New Jersey and southeastern New York.....			² 963,089		² 963,089
Other districts.....	² 938,527	209,092	1,207,715	1,790	² 2,357,124
	² 59,207,857	816,637	² 2,170,804	1,790	62,197,088

¹ Includes only those mines in Wisconsin which are in the true Lake Superior district.

² Some hematite from "Other districts" included with magnetite from Adirondack district.

³ Some hematite included with brown ore.

Iron ore mined in the Lake Superior district, 1919-1928, by ranges, in long tons

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1919.....	4,158,751	4,863,968	7,368,994	1,051,795	33,262,954	1,685,877	52,392,333
1920.....	4,457,609	5,651,542	8,298,206	1,053,518	36,641,880	1,757,775	57,860,530
1921.....	2,204,114	2,147,569	3,135,477	981,576	16,380,190	449,559	25,298,485
1922.....	2,745,626	3,290,641	4,910,789	1,108,764	26,704,601	955,595	39,716,016
1923.....	3,910,909	4,913,541	6,112,662	1,119,113	41,809,018	1,420,165	59,285,408
1924.....	3,579,087	3,780,664	5,579,883	1,141,690	29,818,965	941,430	44,841,719
1925.....	3,813,687	5,009,022	6,377,710	1,331,753	34,851,109	673,382	52,056,663
1926.....	4,046,191	5,445,683	6,949,920	1,568,953	37,997,797	1,134,863	57,143,407
1927.....	4,015,730	5,458,182	6,604,830	1,577,817	32,866,034	1,017,287	51,539,880
1928.....	3,755,343	4,855,735	6,342,092	1,628,289	34,856,333	1,079,383	52,517,175

Iron ore shipped from mines in the United States, 1919-1928

[Exclusive of ore sold for paint. See p. A60]

Year	Long tons	Value	Year	Long tons	Value
1919.....	56,372,784	\$197,312,517	1924.....	52,083,375	\$151,307,105
1920.....	69,281,341	285,006,327	1925.....	63,924,763	160,796,886
1921.....	26,652,528	89,745,308	1926.....	69,292,832	174,015,645
1922.....	50,612,620	157,809,286	1927.....	61,232,473	151,125,820
1923.....	69,811,472	240,738,921	1928.....	63,432,826	155,788,657

Iron ore shipped from mines in the United States, 1927 and 1928, by States

[Exclusive of ore sold for paint. See p. A60]

State	1927		1928	
	Long tons	Value	Long tons	Value
Alabama.....	6, 508, 419	\$12, 973, 597	6, 159, 863	\$11, 599, 176
Colorado.....	32, 206	(1)	52, 713	(1)
Georgia.....	50, 312	147, 068	73, 052	209, 877
Michigan.....	14, 532, 831	37, 135, 364	14, 241, 102	37, 039, 644
Minnesota.....	35, 563, 177	87, 935, 099	38, 129, 018	94, 258, 899
Missouri.....	78, 605	315, 670	94, 899	377, 847
Montana.....	2, 837	10, 156	1, 640	5, 900
New Jersey.....	202, 720	860, 393	350, 616	1, 357, 877
New Mexico.....	214, 747	(1)	184, 623	(1)
New York.....	936, 850	4, 568, 224	767, 743	2, 906, 055
North Carolina.....	32, 528	81, 753	.....	.....
Pennsylvania.....	1, 124, 883	2, 559, 916	1, 013, 791	2, 411, 114
Tennessee.....	121, 220	274, 620	128, 478	286, 524
Utah.....	222, 879	(1)	320, 655	(1)
Virginia.....	66, 897	172, 877	27, 970	83, 114
Washington.....	550	(1)	1, 012	(1)
Wisconsin.....	937, 935	2, 567, 078	1, 394, 371	3, 700, 797
Wyoming.....	602, 877	(1)	491, 280	(1)
Undistributed.....	.....	¹ 1, 524, 005	.....	² 1, 551, 833
	61, 232, 473	151, 125, 820	63, 432, 826	155, 788, 657

¹ Included under "Undistributed."² This figure covers States entered as "(1)" above.*Stocks of iron ore at mines in the United States, December 31, 1919-1928, in long tons*

1919.....	13, 097, 500	1924.....	12, 410, 619
1920.....	11, 378, 794	1925.....	10, 795, 630
1921.....	13, 836, 267	1926.....	9, 565, 880
1922.....	10, 524, 279	1927.....	10, 104, 673
1923.....	10, 165, 875	1928.....	9, 190, 061

Stocks of iron ore at mines in the United States, December 31, 1927 and 1928, in long tons

State	1927	1928	State	1927	1928
Alabama.....	848, 850	996, 751	New York.....	116, 774	71, 732
Iowa.....	12, 165	12, 165	Pennsylvania.....	85, 322	93, 611
Michigan.....	6, 089, 053	5, 556, 372	Virginia.....	22, 060	20, 287
Minnesota.....	2, 518, 000	2, 079, 823	Wisconsin.....	243, 585	290, 004
Missouri.....	2, 629	2, 629			
New Jersey.....	166, 235	66, 687		10, 104, 673	9, 190, 061

Iron ore imported into and exported from the United States, 1919-1928

Year	Imports		Exports	
	Long tons	Value	Long tons	Value
1919.....	476, 461	\$2, 385, 689	996, 569	\$4, 308, 746
1920.....	1, 273, 456	4, 963, 654	1, 145, 037	6, 198, 927
1921.....	315, 768	1, 075, 909	440, 106	2, 077, 620
1922.....	1, 135, 156	4, 916, 294	602, 194	2, 770, 878
1923.....	2, 768, 430	11, 308, 503	1, 116, 932	5, 305, 365
1924.....	2, 047, 055	10, 580, 904	595, 413	2, 407, 003
1925.....	2, 190, 697	6, 895, 229	630, 521	2, 411, 093
1926.....	2, 555, 441	5, 876, 316	868, 710	3, 380, 701
1927.....	2, 620, 717	6, 068, 283	898, 793	3, 425, 435
1928.....	2, 452, 646	5, 428, 019	1, 282, 306	4, 797, 881

PIG IRON

Pig iron shipped from blast furnaces in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919.....	30, 130, 231	\$775, 915, 043	1924.....	31, 064, 129	\$665, 078, 972
1920.....	35, 710, 227	1, 140, 904, 096	1925.....	36, 814, 702	739, 316, 333
1921.....	16, 038, 619	389, 437, 792	1926.....	38, 181, 053	749, 633, 468
1922.....	27, 670, 738	608, 144, 858	1927.....	34, 866, 644	646, 226, 139
1923.....	38, 361, 379	946, 799, 378	1928.....	38, 303, 699	661, 351, 270

Pig iron shipped from blast furnaces in the United States, 1927 and 1928, by States

State	1927		1928	
	Long tons	Value	Long tons	Value
Alabama.....	2, 705, 240	\$50, 193, 057	2, 525, 812	\$42, 194, 935
Colorado.....	(1)	(1)	(1)	(1)
Illinois.....	3, 466, 203	66, 442, 068	4, 094, 514	73, 524, 773
Indiana.....	3, 447, 764	62, 097, 518	3, 842, 762	63, 622, 330
Kentucky.....	184, 851	(1)	225, 545	(1)
Maryland.....	845, 564	(1)	971, 832	(1)
Massachusetts.....	129, 039	(1)	(1)	(1)
Michigan.....	626, 532	12, 527, 993	797, 776	15, 157, 535
Minnesota.....	287, 813	(1)	341, 203	(1)
New York.....	2, 401, 432	40, 803, 579	2, 369, 814	39, 928, 960
Ohio.....	8, 184, 066	150, 125, 790	9, 266, 936	156, 883, 186
Pennsylvania.....	11, 145, 334	212, 179, 275	12, 289, 455	216, 425, 084
Tennessee.....	87, 971	1, 911, 380	102, 718	1, 920, 901
Utah.....	(1)	(1)	164, 071	(1)
Virginia.....	84, 920	1, 782, 538	63, 175	1, 245, 809
West Virginia.....	504, 816	(1)	645, 038	(1)
Wisconsin.....	(1)	(1)	(1)	(1)
Undistributed.....	2 765, 099	2 48, 162, 941	2 603, 048	2 50, 447, 757
	34, 866, 644	646, 226, 139	38, 303, 699	661, 351, 270

¹ Included under "Undistributed."² This figure covers States entered as "(1)" above.*Pig iron ¹ imported into and exported from the United States, 1919-1928*

Year	Imports		Exports	
	Long tons	Value	Long tons	Value
1919 ¹	101, 665	\$6, 565, 106	321, 261	\$12, 313, 183
1920 ¹	185, 944	12, 801, 834	216, 828	10, 074, 377
1921 ¹	44, 036	2, 014, 926	28, 307	933, 093
1922.....	383, 445	8, 670, 860	30, 920	756, 842
1923.....	367, 778	9, 005, 077	32, 318	862, 443
1924.....	209, 109	3, 741, 213	41, 483	957, 921
1925.....	441, 425	7, 951, 283	32, 674	724, 565
1926.....	445, 773	7, 708, 982	25, 208	523, 883
1927.....	132, 568	2, 254, 355	50, 992	1, 028, 425
1928.....	140, 694	2, 232, 094	84, 682	1, 366, 794

¹ Figures for 1919 to 1921 include ferro-alloys. Separate data not available prior to 1922.

STEEL

*Steel produced in the United States, 1919-1928, in long tons*¹

Year	Bessemer	Open-hearth	Crucible	Other steel	Total
1919.....	7,271,562	26,948,694	63,572	387,404	34,671,232
1920.....	8,883,087	32,671,895	72,265	505,687	42,132,934
1921.....	4,015,938	15,589,802	7,613	170,444	19,783,797
1922.....	5,919,298	29,308,983	28,606	346,039	35,602,926
1923.....	8,484,088	35,899,657	44,079	515,872	44,943,696
1924.....	5,899,590	31,577,350	22,473	432,526	37,931,939
1925.....	6,723,962	38,034,488	19,562	615,512	45,393,524
1926.....	6,934,568	40,691,979	15,493	651,723	48,293,763
1927.....	6,191,727	38,068,335	9,036	666,087	44,935,185
1928.....	6,620,195	44,113,956	7,769	802,260	51,544,180

¹ According to the American Iron and Steel Institute.LEAD¹*Refined primary lead produced in the United States from domestic ores, 1919-1928*

Year	Short tons	Value	Year	Short tons	Value
1919.....	424,433	\$44,990,000	1924.....	566,407	\$90,625,000
1920.....	476,849	76,296,000	1925.....	654,921	113,956,000
1921.....	398,222	35,840,000	1926.....	680,685	108,910,000
1922.....	468,746	51,562,000	1927.....	668,320	84,208,000
1923.....	543,841	76,138,000	1928.....	626,202	72,639,000

¹ For prices of lead, see statement on p. A8.*Refined primary lead produced in the United States, 1924-1928, in short tons*

	1924	1925	1926	1927	1928
Domestic ore:					
Desilverized lead.....	299,343	345,429	366,413	378,889	351,734
Soft lead.....	203,615	260,560	258,565	233,944	225,003
Desilverized soft lead.....	63,449	48,932	55,707	55,487	49,465
Total from domestic ore.....	566,407	654,921	680,685	668,320	626,202
Foreign ore:					
Africa.....	6		6	12	
Canada.....	4,633	10,676	5,385	4,138	10,123
Central America.....	30	6		18	3
Mexico.....	33,328	31,107	32,693	22,674	14,839
South America.....	7,663	4,496	9,893	5,506	1,568
Other foreign.....	725	739	233	21	99
Foreign base bullion:					
Mexico.....	77,701	65,024	70,046	95,841	117,193
Peru.....					11,044
Total from foreign ore and base bullion.....	124,086	112,048	118,256	128,210	154,869
Grand total from all sources.....	690,493	766,969	798,941	796,530	781,071
Production of antimonial lead.....	20,787	19,667	22,524	24,347	33,058

Secondary lead recovered in the United States, 1919-1928

Year	Pig lead (short tons)	Lead in alloys (short tons)	Total	
			Short tons	Value
1919.....	55,684	66,416	122,100	\$12,943,000
1920.....	56,350	68,300	124,650	19,944,000
1921.....	46,370	57,410	103,780	9,340,000
1922.....	75,480	84,080	159,560	17,552,000
1923.....	96,430	98,060	194,490	27,229,000
1924.....	90,400	114,100	204,500	32,720,000
1925.....	112,420	114,460	226,880	39,477,100
1926.....	125,000	152,300	277,300	44,368,000
1927.....	119,000	157,000	276,000	34,776,000
1928.....	138,000	170,600	308,600	35,797,600

Lead imported for consumption in the United States, 1919-1928, by classes

Year	Lead in ore ¹		Lead in base bullion		Pigs, bars, and old ²		Sheets, pipe, and shot		Not otherwise specified (value)	Total value
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
1919.....	4, 106, 823	\$196, 363	31, 796, 693	\$1, 130, 937	10, 174, 115	\$415, 094	8, 018	\$628	\$17, 187	\$1, 760, 209
1920.....	13, 700, 499	908, 619	66, 816, 820	3, 340, 600	68, 901, 959	3, 887, 821	81, 396	5, 483	21, 328	8, 163, 851
1921.....	6, 842, 807	327, 046	56, 819, 980	1, 668, 410	61, 909, 094	1, 972, 716	3, 087	140	11, 204	3, 979, 516
1922.....	23, 649, 851	812, 603	55, 859, 422	1, 815, 142	8, 563, 110	335, 924	6, 018	697	12, 286	2, 976, 652
1923.....	22, 420, 046	1, 190, 414	11, 124, 151	626, 201	42, 925, 265	2, 510, 466	19, 525	4, 495	90, 027	4, 421, 603
1924.....	65, 147, 976	3, 145, 791	28, 796, 402	1, 542, 167	27, 362, 392	1, 850, 862	11, 666	4, 384	138, 637	6, 681, 841
1925.....	12, 706, 508	672, 112	24, 747, 665	1, 823, 566	15, 464, 205	1, 038, 350	27, 579	10, 429	139, 533	3, 683, 990
1926.....	58, 752, 911	3, 393, 039	13, 341, 038	972, 758	24, 365, 570	2, 191, 658	864, 342	101, 322	62, 895	6, 721, 672
1927.....	70, 260, 478	4, 203, 897	14, 629, 606	925, 328	9, 933, 679	635, 807	988, 170	104, 890	52, 626	5, 922, 548
1928.....	46, 511, 508	2, 626, 231	13, 397, 455	560, 983	20, 488, 373	808, 359	775, 329	67, 131	134, 995	4, 197, 099

¹ Includes also lead in matte beginning Sept. 22, 1922, when change in tariff went into effect.

² Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., beginning Sept. 22, 1922, when change in tariff went into effect, except in 1925, 1926, 1927, and 1928, when antimonial lead is excluded.

Lead imported into the United States in ore, base bullion, and refined, by sources, 1924-1928, in pounds

[General imports]

Year	Canada	Mexico	South America	Europe	Other countries	Total
1924.....	11, 022, 091	243, 161, 069	15, 820, 867	4, 857, 805	453, 432	275, 315, 264
1925.....	11, 646, 820	218, 873, 800	10, 621, 737	1, 594, 963	1, 521, 110	244, 258, 430
1926.....	12, 316, 740	254, 203, 852	24, 790, 075	3, 224, 504	572, 856	295, 108, 027
1927.....	6, 214, 867	300, 634, 815	14, 583, 513	1, 226, 049	118, 883	322, 778, 127
1928.....	14, 352, 967	275, 184, 287	20, 408, 574	56, 406	85, 915	310, 088, 149

Lead imported into the United States, by classes, 1924-1928, in pounds

[General imports]

Year	Lead in ore	Lead in base bullion	Pigs, bars, sheets, and old	Total lead content
1924.....	95, 320, 168	155, 501, 350	24, 493, 746	275, 315, 264
1925.....	88, 962, 502	141, 253, 559	14, 642, 369	244, 258, 430
1926.....	116, 232, 669	156, 570, 738	22, 304, 620	295, 108, 027
1927.....	81, 276, 126	236, 567, 252	4, 934, 749	322, 778, 127
1928.....	51, 829, 530	256, 935, 461	1, 323, 158	310, 088, 149

Lead exported from the United States, 1919-1928, by classes

Year	Pigs and bars				Foreign lead used in ar- ticles ex- ported with benefit of drawback ¹	Manufac- tures of lead from both do- mestic and foreign ores
	From domestic ore		From foreign ore			
	Pounds	Value	Pounds	Value	Pounds	
1919.....	21, 019, 605	\$1, 471, 256	81, 951, 396	\$4, 536, 273	3, 872, 130	\$2, 155, 436
1920.....	5, 459, 713	462, 223	34, 725, 501	2, 570, 535	12, 350, 794	3, 621, 397
1921.....	3, 247, 294	177, 926	50, 000, 259	2, 284, 107	18, 738, 927	1, 376, 259
1922.....	11, 645, 821	604, 605	64, 709, 305	3, 177, 360	11, 354, 070	1, 158, 150
1923.....	3, 997, 485	260, 487	97, 471, 326	5, 195, 256	25, 052, 107	1, 078, 636
1924.....	10, 664, 083	711, 147	153, 515, 863	9, 685, 619	30, 549, 116	1, 965, 555
1925.....	9, 910, 955	784, 440	197, 128, 517	14, 910, 891	23, 398, 305	2, 006, 309
1926.....	8, 551, 639	601, 061	135, 319, 321	8, 904, 603	35, 910, 934	3, 297, 704
1927.....	5, 066, 035	308, 698	245, 467, 875	12, 508, 566	24, 008, 803	1, 318, 134
1928.....	28, 403, 279	1, 299, 021	204, 134, 083	9, 060, 200	26, 448, 902	1, 645, 909

¹ Exclusive of lead that entered as pig and was exported in the same form, which would be duplicated in exports of lead from foreign ore.

LIME

Lime sold by producers in the United States, 1919-1928

Year	Hydrated			Total		
	Number of plants in operation	Short tons	Value ¹	Number of plants in operation	Short tons	Value ¹
1919.....	93	777,408	\$7,061,146	539	3,330,347	\$29,448,553
1920.....	98	853,116	9,287,562	515	3,570,141	37,543,840
1921.....	105	792,970	7,421,637	520	2,532,153	24,895,370
1922.....	114	1,106,063	9,868,980	530	3,639,617	33,255,039
1923.....	121	1,225,928	12,229,598	467	4,076,243	39,993,652
1924.....	120	1,316,664	13,199,486	450	4,072,000	39,596,423
1925.....	134	1,560,848	15,287,461	450	4,580,823	42,609,141
1926.....	147	1,606,811	15,182,460	435	4,560,398	41,566,452
1927.....	157	1,596,906	14,581,695	417	4,414,932	38,638,413
1928.....	164	1,612,818	13,540,215	411	4,458,412	36,449,635

¹ The value given represents the value of bulk lime f. o. b. at point of shipment and does not include cost of barrel or package.

Lime sold by producers in the United States, 1927 and 1928, by States

State	1927			1928		
	Number of plants in operation	Short tons	Value	Number of plants in operation	Short tons	Value
Alabama.....	10	206,010	\$1,566,287	11	192,364	\$1,407,232
Arizona.....	3	41,859	390,074	2	36,244	343,167
Arkansas.....	4	35,375	307,335	5	40,438	339,624
California.....	8	64,934	708,010	9	60,751	617,472
Colorado.....	4	11,900	125,875	3	8,114	88,775
Connecticut.....	6	53,304	608,550	6	48,152	529,936
Florida.....	3	5,317	59,491	3	4,748	50,086
Georgia.....	1	13,533	99,604	1	12,890	83,045
Hawaii.....	1	5,679	95,857	1	6,284	72,092
Idaho.....	2	(1)	(1)	1	(1)	(1)
Illinois.....	10	115,803	1,084,093	8	115,523	1,017,001
Indiana.....	8	116,171	830,527	8	107,209	734,915
Iowa.....	2	(1)	(1)	2	(1)	(1)
Kentucky.....	3	6,862	47,620	2	(1)	(1)
Maine.....	5	116,566	1,230,356	4	123,023	1,056,443
Maryland.....	8	55,405	439,457	11	59,508	440,886
Massachusetts.....	10	189,343	2,325,031	8	171,944	2,026,019
Michigan.....	8	101,172	931,597	8	104,917	962,708
Minnesota.....	3	(1)	(1)	3	(1)	(1)
Missouri.....	15	267,776	2,189,420	14	303,014	2,252,420
Montana.....	3	11,607	90,512	2	(1)	(1)
Nevada.....	1	(1)	(1)	1	(1)	(1)
New Jersey.....	2	(1)	(1)	2	(1)	(1)
New Mexico.....	3	2,042	20,480	2	2,062	19,665
New York.....	14	98,071	905,116	13	93,354	794,301
North Carolina.....	1	(1)	(1)	1	(1)	(1)
Ohio.....	31	987,726	9,497,324	28	1,013,676	8,919,596
Oklahoma.....	2	(1)	(1)	-----	-----	-----
Oregon.....	3	1,105	21,350	3	2,090	34,372
Pennsylvania.....	122	813,571	6,105,241	130	834,050	6,119,036
Porto Rico.....	14	7,516	116,618	15	9,405	147,040
Rhode Island.....	1	2,937	43,342	1	2,589	36,875
South Dakota.....	2	(1)	(1)	2	(1)	(1)
Tennessee.....	11	181,385	1,266,326	9	183,541	1,238,945
Texas.....	6	80,796	733,678	5	82,325	751,729
Utah.....	10	48,882	397,088	11	47,662	385,476
Vermont.....	10	61,024	683,440	8	52,445	485,235
Virginia.....	28	178,426	1,317,581	32	174,067	1,208,618
Washington.....	4	23,959	382,294	4	24,529	265,922
West Virginia.....	12	244,950	1,643,109	12	279,947	1,788,989
Wisconsin.....	22	197,667	1,733,009	20	163,965	1,374,749
Wyoming.....	1	30	600	-----	-----	-----
Undistributed.....	-----	66,229	642,121	-----	97,642	857,266
	417	4,414,932	38,638,413	411	4,458,412	36,449,635

¹ Included under "Undistributed."

Lime imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Short tons	Value	Short tons	Value
1919.....	8, 679	\$128, 519	6, 372	\$108, 370
1920.....	22, 688	392, 137	5, 921	128, 296
1921.....	10, 811	234, 798	5, 192	109, 769
1922.....	14, 112	290, 845	8, 289	116, 649
1923.....	25, 407	428, 903	11, 789	170, 289
1924.....	20, 480	377, 994	14, 905	212, 340
1925.....	15, 323	285, 599	14, 800	218, 696
1926.....	18, 702	346, 969	12, 960	191, 768
1927.....	19, 567	356, 836	15, 478	210, 977
1928.....	18, 321	344, 296	18, 188	245, 004

LITHIUM MINERALS*Lithium minerals produced in the United States, 1919-1928*

Year	Short tons	Value	Year	Short tons	Value
1919.....	6, 287	\$115, 000	1924.....	2, 996	\$62, 391
1920.....	11, 696	173, 002	1925.....	3, 140	58, 500
1921.....	1, 833	33, 508	1926.....	3, 700	53, 400
1922.....	2, 192	41, 300	1927.....	4, 173	59, 656
1923.....	2, 310	38, 800	1928.....	4, 600	94, 750

Imports and exports of lithium minerals are not reported separately.

LITHOGRAPHIC STONE

No domestic production of lithographic stone in the United States has been reported since 1918.

Lithographic stone imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	464, 914	\$216, 293	1924.....	133, 674	\$9, 046
1920.....	786, 119	63, 733	1925.....	186, 971	20, 263
1921.....	301, 546	34, 101	1926.....	248, 698	28, 201
1922.....	256, 426	28, 242	1927.....	45, 398	6, 790
1923.....	225, 600	24, 861	1928.....	63, 505	9, 963

No exports of lithographic stone are reported.

MAGNESITE*Domestic magnesite (expressed as equivalent crude) sold or treated in the United States, 1919-1928*

Year	California		Washington		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	50, 020	\$504, 973	106, 206	\$743, 442	156, 226	\$1, 248, 415
1920.....	81, 782	1, 083, 262	221, 985	1, 664, 888	303, 767	2, 748, 150
1921.....	47, 904	510, 177			47, 904	510, 177
1922.....	¹ 55, 790	¹ 571, 745	(1)	(1)	55, 790	571, 745
1923.....	73, 350	938, 600	73, 900	165, 100	147, 250	1, 103, 700
1924.....	67, 240	901, 700	52, 860	139, 600	120, 100	1, 041, 300
1925.....	64, 600	872, 100	56, 060	560, 600	120, 660	1, 432, 700
1926.....	53, 940	604, 130	79, 560	596, 700	133, 500	1, 200, 830
1927.....	43, 750	507, 500	77, 740	583, 050	121, 490	1, 090, 550
1928.....	41, 300	454, 300	85, 900	644, 250	127, 200	1, 098, 550

¹ Washington included with California. Bureau of Mines not at liberty to publish figures.

Magnesite imported for consumption in the United States, 1919-1928

Year	Crude		Calcined	
	Short tons	Value	Short tons	Value
1919.....	6,381	\$103,311	9,471	\$270,721
1920.....	33,550	406,204	14,780	373,165
1921.....	51,993	525,452	6,788	250,932
1922.....	73,331	976,283	72,265	1,267,622
1923.....	5,182	44,081	72,955	1,022,968
1924.....	6	85	64,785	1,172,403
1925.....	487	6,382	68,395	1,160,830
1926.....	608	6,555	90,293	1,438,765
1927.....	856	8,574	59,261	946,361
1928.....	762	6,264	62,481	966,183

Exports are not separately recorded.

MAGNESIUM*Domestic metallic magnesium sold or used in the United States, 1919-1928*

Year	Number of producers	Pounds	Value	Year	Number of producers	Pounds	Value
1919.....	3	127,465	\$247,302	1924.....	2	¹ 123,000	¹ \$150,000
1920.....	2	(?)	(?)	1925.....	2	245,000	274,400
1921.....	1	48,000	86,000	1926.....	2	322,650	390,400
1922.....	2	¹ 60,000	¹ 89,000	1927.....	2	366,400	441,700
1923.....	2	¹ 125,000	¹ 155,000	1928.....	2	483,000	587,000

¹ Estimate.

² Bureau of Mines not at liberty to publish figures.

Magnesium imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	13,239	\$13,583	1924.....	8,738	\$6,561
1920.....	29,275	25,055	1925.....	8,326	7,670
1921.....	39,913	30,592	1926.....	10,117	4,750
1922.....	182,939	54,448	1927.....	7,131	8,402
1923.....	13,974	11,576	1928.....	12,039	11,890

Exports are not separately recorded.

MANGANESE*Manganese and mangiferous ore (exclusive of fluxing ore) shipped from mines in the United States, 1919-1928*

Year	Ore containing 35 per cent of manganese or more			Ore containing 10 to 35 per cent of manganese			Ore containing 5 to 10 per cent of manganese		
	Number of ship-pers	Long tons	Value	Number of ship-pers	Long tons	Value	Number of ship-pers	Long tons	Value
1919.....	42	54,957	\$1,791,118	24	211,632	\$965,660	9	112,303	\$352,570
1920.....	56	94,420	2,396,235	31	357,279	1,450,518	6	279,687	644,572
1921.....	14	13,531	495,097	6	8,439	42,755	3	62,670	147,576
1922.....	18	13,404	455,160	9	344,674	1,071,780	6	251,614	632,039
1923.....	36	31,500	874,973	41	319,666	1,158,628	12	1,072,457	3,598,327
1924.....	39	56,515	1,307,477	55	286,470	929,390	12	587,026	1,713,943
1925.....	42	98,324	1,857,769	53	267,252	915,316	11	1,153,298	2,799,403
1926.....	34	46,258	1,228,663	54	364,312	1,179,429	8	835,412	1,934,381
1927.....	39	44,741	1,151,918	47	148,291	673,921	9	1,310,127	3,270,460
1928.....	38	46,860	1,214,853	31	90,581	407,289	8	1,085,401	2,645,165

Manganese and manganiferous ore (for fluxing purposes) shipped from mines in the United States, 1919-1928

Year	Ore containing 35 per cent of manganese or more		Ore containing 10 to 35 per cent of manganese		Ore containing 5 to 10 per cent of manganese	
	Long tons	Value	Long tons	Value	Long tons	Value
1919.....	365	\$5,745	98,202	\$216,868	11,596	\$17,394
1920.....	-----	-----	123,970	332,615	6,728	10,093
1921.....	-----	-----	22,962	¹ 57,000	3,028	¹ 7,800
1922.....	2,278	17,341	27,705	¹ 52,000	1,666	¹ 10,600
1923.....	769	(²)	40,770	^{1 2} 134,133	1,004	^{1 2} 510
1924.....	1,833	(²)	24,972	^{1 2} 107,215	-----	-----
1925.....	-----	-----	25,384	¹ 36,177	2,150	¹ 1,590
1926.....	-----	-----	17,707	24,679	-----	-----
1927.....	-----	-----	1,029	³ 2,635	2,161	(³)
1928.....	-----	-----	48	³ 853	1,602	(³)

¹ Partly estimated.

² Value for 35 per cent ore included with that for 10-35 per cent ore. Bureau of Mines not at liberty to publish figures.

³ Value for 5-10 per cent ore included with that for 10-35 per cent ore. Bureau of Mines not at liberty to publish figures.

Manganese and manganiferous ore (exclusive of fluxing ore) shipped from mines in the United States, 1927 and 1928, by States

State	Ore containing 35 per cent of manganese or more			Ore containing 10 to 35 per cent of manganese			Ore containing 5 to 10 per cent of manganese		
	Number of shippers	Long tons	Value	Number of shippers	Long tons	Value	Number of shippers	Long tons	Value
1927									
Alabama.....	2	(¹)	(¹)	2	(¹)	(¹)	-----	-----	-----
Arizona.....	3	3,905	\$41,880	1	179	\$754	-----	-----	-----
Arkansas.....	8	2,605	64,202	6	7,444	48,678	-----	-----	-----
Colorado.....	1	(¹)	(¹)	5	26,828	126,938	-----	-----	-----
Georgia.....	2	489	(¹)	16	20,015	135,606	1	195	(¹)
Idaho.....	1	3,181	50,900	-----	-----	-----	-----	-----	-----
Massachusetts.....	-----	-----	-----	1	(¹)	(¹)	-----	-----	-----
Michigan.....	-----	-----	-----	1	14,763	(¹)	1	59,976	(¹)
Minnesota.....	-----	-----	-----	1	6,276	22,272	4	934,599	\$2,169,779
Montana:									
Metallurgical.....	4	10,124	158,900	1	10,332	(¹)	-----	-----	-----
Chemical.....	² 2	16,382	(¹)	-----	-----	-----	-----	-----	-----
Nevada.....	3	1,357	16,976	2	3,310	(¹)	-----	-----	-----
New Mexico.....	3	2,190	37,237	1	56,624	(¹)	1	30,710	(¹)
Tennessee.....	3	498	8,182	3	487	3,442	-----	-----	-----
Utah.....	1	27	(¹)	4	239	(¹)	-----	-----	-----
Virginia:									
Metallurgical.....	5	2,583	48,860	3	1,029	7,500	1	177	(¹)
Chemical.....	1	629	(¹)	-----	-----	-----	-----	-----	-----
Wisconsin.....	-----	-----	-----	-----	-----	-----	1	284,470	818,604
Undistributed.....	-----	771	724,781	-----	765	328,731	-----	282,077	-----
	39	44,741	1,151,918	47	148,291	673,921	9	1,310,127	3,270,460
1928									
Alabama.....	2	(¹)	(¹)	-----	-----	-----	-----	-----	-----
Arizona.....	5	3,507	35,500	1	214	(¹)	-----	-----	-----
Arkansas.....	6	3,623	81,862	4	7,136	43,880	-----	-----	-----
Colorado.....	-----	-----	-----	4	18,599	99,823	-----	-----	-----
Georgia.....	1	4,727	(¹)	8	4,687	41,322	-----	-----	-----
Idaho.....	2	(¹)	(¹)	-----	-----	-----	-----	-----	-----
Michigan.....	-----	-----	-----	2	7,943	(¹)	1	41,261	(¹)
Minnesota.....	-----	-----	-----	1	3,487	(¹)	5	1,025,014	2,471,582
Montana:									
Metallurgical.....	3	12,044	(¹)	1	11,156	(¹)	-----	-----	-----
Chemical.....	² 2	14,689	(¹)	-----	-----	-----	-----	-----	-----
New Mexico.....	3	2,627	(¹)	2	36,250	(¹)	1	19,081	(¹)
North Carolina.....	1	10	(¹)	-----	-----	-----	-----	-----	-----
Tennessee.....	2	55	(¹)	5	718	6,778	1	45	(¹)
Utah.....	-----	-----	-----	1	286	(¹)	-----	-----	-----
Virginia:									
Metallurgical.....	10	3,071	50,106	2	105	(¹)	-----	-----	-----
Chemical.....	1	741	(¹)	-----	-----	-----	-----	-----	-----
Undistributed.....	-----	1,766	1,047,385	-----	-----	215,486	-----	173,583	-----
	38	46,860	1,214,853	31	90,581	407,289	8	1,085,401	2,645,165

¹ Included under "Undistributed."

² Figure represents mills through which all shipments were made; individual producers not counted.

Manganiferous iron ore shipped from the Cuyuna district, Minnesota, 1919-1928, in long tons

Year	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese	Year	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese
1919.....	138,952	98,220	1924.....	159,915	361,527
1920.....	293,524	248,913	1925.....	77,665	741,409
1921.....	.....	56,530	1926.....	158,759	799,458
1922.....	305,093	248,560	1927.....	6,276	934,599
1923.....	253,634	499,181	1928.....	3,487	1,025,014

Manganese ore imported for consumption in the United States, 1919-1928

Year	Long tons		Value	Year	Long tons		Value
	Gross weight	Manganese content			Gross weight	Manganese content	
1919.....	333,344	(¹)	\$11,229,184	1924.....	(¹)	² 224,230	\$5,305,791
1920.....	606,937	(¹)	12,230,922	1925.....	(¹)	² 277,055	7,417,582
1921.....	401,354	(¹)	3,365,732	1926.....	(¹)	² 297,630	9,612,673
1922 (Jan. 1-Sept. 21).....	327,727	(¹)	2,695,724	1927.....	620,212	304,388	9,271,920
1922 (Sept. 22-Dec. 31).....	(¹)	² 18,124	364,247	1928.....	565,938	269,712	6,827,621
1923.....	(¹)	² 78,391	1,674,914				

¹ Not recorded by Bureau of Foreign and Domestic Commerce.

² Includes estimate by the Bureau of Mines for manganese content of ore imported from Cuba. The Bureau of Foreign and Domestic Commerce recorded only gross weight of Cuban ore imported, and the figures for such ore were as follows: 1922 (Sept. 22 to Dec. 31), 190 long tons; 1923, 9,062 tons; 1924, 23,065 tons; 1925, 12,745 tons; 1926, 14,112 tons.

No separate record of exports of manganese ore is kept.

MANGANIFEROUS ZINC RESIDUUM

Manganiferous zinc residuum is recovered from roasted franklinite concentrates at Franklin Furnace, N. J. Nearly all of this residuum is reduced to spiegeleisen by the company that produces it. The Bureau of Mines is not at liberty to publish value.

Manganiferous residuum, from zinc roasting in the United States, shipped in 1919-1928, in long tons

1919.....	80,418	1924.....	119,457
1920.....	133,602	1925.....	147,937
1921.....	12,627	1926.....	179,926
1922.....	81,333	1927.....	(¹)
1923.....	132,801	1928.....	171,107

¹ Bureau of Mines not at liberty to publish figures.

MARLS

Calcareous marl sold by producers in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	91, 437	\$327, 294	1924.....	72, 710	\$225, 383
1920.....	97, 487	322, 339	1925.....	68, 670	187, 839
1921.....	59, 730	195, 743	1926.....	55, 060	146, 094
1922.....	67, 777	203, 196	1927.....	52, 962	180, 166
1923.....	99, 410	328, 932	1928.....	61, 034	200, 704

Greensand marl produced in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	(¹)	(¹)	1924.....	14, 055	\$151, 205
1920.....	(¹)	(¹)	1925.....	12, 728	179, 788
1921.....	2, 058	\$10, 200	1926.....	12, 681	174, 740
1922.....	7, 885	56, 800	1927.....	11, 911	168, 683
1923.....	10, 656	131, 123	1928.....	12, 988	207, 042

¹ Bureau of Mines not at liberty to publish figures.

No imports or exports of marl are reported.

MERCURY

Mercury produced in the United States, 1919-1928

[Flasks of 75 pounds]

Year	Flasks	Value	Year	Flasks	Value
1919.....	21, 415	\$1, 933, 560	1924.....	10, 085	\$692, 739
1920.....	13, 392	1, 066, 807	1925.....	9, 174	762, 616
1921.....	6, 339	300, 595	1926.....	7, 642	702, 323
1922.....	6, 375	368, 348	1927.....	11, 276	1, 314, 782
1923.....	7, 937	521, 302	1928.....	18, 108	2, 207, 003

Mercury imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Flasks	Value	Flasks	Value
1919.....	10, 635	\$791, 226	9, 107	\$817, 328
1920.....	14, 169	971, 510	1, 553	129, 993
1921.....	10, 601	457, 993	393	18, 869
1922.....	16, 920	757, 842	291	15, 910
1923.....	18, 073	816, 043	318	25, 195
1924.....	13, 170	566, 820	208	14, 333
1925.....	20, 855	1, 200, 878	204	15, 930
1926.....	25, 976	1, 784, 250	116	10, 319
1927.....	20, 207	1, 780, 134	(¹)	(¹)
1928.....	14, 756	1, 437, 153	(¹)	(¹)

¹ Exports of mercury not separately recorded for 1927 and 1928.

MICA

Mica¹ sold by producers in the United States, 1919-1928

Year	Sheet mica ¹		Scrap mica		Total ¹	
	Pounds	Value	Short tons	Value	Short tons	Value
1919-----	1,545,709	\$483,567	3,258	\$58,084	4,031	\$541,651
1920-----	1,683,480	546,972	5,723	167,017	6,565	713,989
1921-----	741,845	118,513	2,577	56,849	2,948	175,362
1922-----	1,077,968	194,301	² 6,641	114,045	² 7,180	308,346
1923-----	2,063,179	311,180	² 8,054	129,695	² 9,086	440,875
1924-----	1,460,897	212,035	4,709	87,242	5,439	299,277
1925-----	1,793,865	321,962	9,695	173,537	10,592	495,499
1926-----	2,172,159	400,184	7,043	136,643	8,129	536,827
1927-----	1,512,492	212,482	6,280	110,139	7,036	322,621
1928-----	1,681,777	230,956	7,760	132,422	8,601	363,378

¹ For 1920 and later years the figures for sheet mica represent uncut sheet exclusively; for 1919 some cut sheet was included.

² Includes mica derived from mica schist.

Mica imported for consumption in the United States, 1919-1928

Year	Sheet				Ground		Total	
	Unmanufactured		Cut and splittings					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919-----	723,713	\$726,532	(1)	\$762,228	62	\$9	(1)	\$1,488,769
1920-----	1,298,537	1,177,943	(1)	2,011,434	-----	-----	(1)	3,189,377
1921-----	328,444	331,219	(1)	758,521	134,650	2,166	(1)	1,091,906
1922-----	385,653	359,793	(1)	² 966,315	313,745	4,514	(1)	1,330,622
1923-----	1,044,366	532,375	² 4,419,102	² 1,844,149	1,867,385	28,324	7,330,853	2,404,848
1924-----	671,793	419,154	² 3,787,251	² 1,885,718	1,342,107	22,034	5,801,151	2,326,906
1925-----	604,550	526,292	² 3,346,144	² 1,259,415	950,614	13,120	4,901,308	1,798,827
1926-----	818,381	562,300	² 5,358,983	² 1,886,486	140,732	2,048	6,318,096	2,450,834
1927-----	776,307	399,302	² 2,683,340	² 1,231,007	-----	-----	3,459,647	1,630,309
1928-----	541,635	294,194	² 3,563,190	² 1,132,248	150	53	4,104,975	1,426,495

¹ Quantity not reported.

² Includes also value of "built up, washers, and other manufactures" (\$20,899) imported Sept. 22 to Dec. 31. Not separately classified prior to change in tariff.

³ Composed of following: 1923, "Cut mica" 60,135 pounds, \$49,268; "splittings" 4,301,727 pounds, \$1,730,532; "built up" 30,032 pounds, \$37,382; and "washers and other" 27,208 pounds, \$26,967; 1924, "Cut mica" 74,534 pounds, \$69,018; "splittings" 3,619,229 pounds, \$1,681,774; "built up" 18,205 pounds, \$41,455; and "washers and other" 75,283 pounds, \$93,471; 1925, "Cut mica" 41,284 pounds, \$63,466; "splittings" 3,239,554 pounds, \$1,113,202; "built up" 14,639 pounds, \$16,785; and "washers and other" 50,667 pounds, \$65,962; 1926, "Cut mica" 46,662 pounds, \$44,621; "splittings" 5,229,858 pounds, \$1,750,434; "built up" 15,147 pounds, \$15,410; and "washers and other" 67,316 pounds, \$76,021; 1927, "Cut mica" 64,075 pounds, \$75,469; "splittings" 2,588,253 pounds, \$1,123,808; "built up" 8,097 pounds, \$9,211; and "washers and other" 22,915 pounds, \$22,519; 1928, "Cut mica" 49,555 pounds, \$93,964; "splittings" 3,496,353 pounds, \$1,025,790; "built up" 4,986 pounds, \$4,539; and "washers and other" 12,296 pounds, \$7,955.

Value of mica exported from the United States, 1919-1928

1919-----	\$109,348	1924-----	\$169,741
1920-----	316,169	1925-----	198,596
1921-----	153,990	1926-----	230,511
1922-----	129,186	1927-----	207,263
1923-----	182,162	1928-----	229,391

MILLSTONES

[See Abrasive materials]

MINERAL PAINTS

Domestic zinc and lead pigments,¹ made in large part direct from ores in the United States, sold by producers, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	155,648	\$25,810,671	1924.....	173,859	\$25,711,159
1920.....	143,244	24,564,572	1925.....	199,190	28,310,631
1921.....	102,463	14,801,032	1926.....	184,289	25,896,269
1922.....	162,815	22,205,400	1927.....	191,853	25,275,975
1923.....	163,240	23,660,381	1928.....	202,363	26,017,743

¹ Include sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.

The canvass of natural mineral pigments was discontinued after 1915. Figures covering iron ore sold for paint, 1919 to 1928, follow.

Iron ore sold for paint, by producers, in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	17,885	\$84,630	1924.....	23,106	\$103,626
1920.....	27,382	112,364	1925.....	29,704	140,986
1921.....	11,624	56,824	1926.....	23,707	129,541
1922.....	30,668	166,682	1927.....	25,023	132,007
1923.....	27,823	140,306	1928.....	17,815	83,190

MINERAL WATERS

Natural mineral waters sold by producers in the United States, 1919-1923¹

Year	Gallons	Value	Year	Gallons	Value
1919.....	38,697,280	\$4,880,186	1922.....	38,492,881	\$5,498,269
1920.....	36,218,260	4,860,915	1923.....	44,430,998	6,493,177
1921.....	34,781,238	4,876,445			

¹ Canvass discontinued after 1923.

Mineral waters (natural and artificial) imported for consumption in the United States, 1919-1928

Year	Gallons	Value	Year	Gallons	Value
1919.....	203,014	\$116,948	1924.....	758,771	\$323,908
1920.....	527,114	203,901	1925.....	794,593	355,411
1921.....	524,765	167,101	1926.....	807,638	360,221
1922.....	698,751	269,245	1927.....	1,000,038	500,757
1923.....	722,657	279,875	1928.....	804,502	396,006

Large quantities of a few domestic waters are exported, but no figures are available prior to 1922. Exports of natural and artificial mineral waters have been as follows: 1922, 209,219 gallons, valued at \$169,473; 1923, 227,831 gallons, \$193,248; 1924, 221,203 gallons, \$179,418; 1925, 206,754 gallons, \$178,828; 1926, 255,860 gallons, \$191,798; 1927, 197,978 gallons, \$173,145; 1928, 195,191 gallons, \$184,231.

MOLYBDENUM

Molybdenum in ore and concentrates, produced in the United States, sold in 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	297,926	\$341,814	1924.....	297,174	(1)
1920.....	34,900	17,207	1925.....	1,154,050	² \$961,324
1921.....	-----	-----	1926.....	(3)	(3)
1922.....	-----	-----	1927.....	2,286,075	1,858,786
1923.....	22,667	(1)	1928.....	3,329,214	1,924,600

¹ Value not reported.

² Estimate by Bureau of Mines.

³ Bureau of Mines not at liberty to publish figures.

"Molybdenum ore" ¹ (steel-hardening)" imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	² 106,743	\$77,572	1924.....	² 10,379	\$9,038
1920.....	² 15,639	9,707	1925.....	² 1,954	1,793
1921.....	² 29,783	20,471	1926.....	² 13,397	11,175
1922.....	² 412,221	90,015	1927.....	² 12,541	10,472
1923.....	² 16,671	13,115	1928.....	-----	-----

¹ Prior to Sept. 22, 1922, imports recorded as ore; beginning with change in tariff, recorded as molybdenum content of ore.

² Recorded as molybdenum ore.

³ Recorded as molybdenum content of ore.

For imports of ferromolybdenum, see under Ferro-alloys.
Exports of ferromolybdenum are not separately classified.

MONAZITE

[See Thorium minerals]

NICKEL

Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1919-1928, and from mixed ores in 1919 and 1920

Year	Short tons	Value	Year	Short tons	Value
1919 ¹	511	\$434,485	1924.....	191	\$114,903
1920 ¹	365	293,250	1925.....	272	169,664
1921.....	111	86,000	1926.....	323	234,558
1922.....	208	133,191	1927.....	860	390,740
1923.....	100	71,605	1928.....	522	291,836

¹ Including nickel produced from copper-lead-cobalt-nickel ores mined in Missouri.

Secondary nickel recovered as metal and in nonferrous alloys and salts in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	2,447	\$1,829,400	1924.....	2,240	\$1,227,500
1920.....	2,200	1,733,600	1925.....	2,300	1,518,000
1921.....	945	680,400	1926.....	3,050	2,135,000
1922.....	1,512	967,700	1927.....	3,380	2,366,000
1923.....	1,550	1,109,800	1928.....	4,500	3,150,000

Value of nickel imported for consumption in the United States, 1919-1928

Year	Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc.	Manufactures and nickel sheets and strips	Total
1919.....	\$8,334,564	\$90,451	\$8,425,015
1920.....	10,657,523	200,464	10,857,987
1921.....	1,220,347	107,155	1,327,502
1922.....	3,945,309	110,176	4,055,485
1923.....	6,602,096	94,832	6,696,928
1924.....	6,132,984	70,755	6,203,739
1925.....	7,772,320	98,761	7,871,081
1926.....	9,409,567	65,166	9,474,733
1927.....	8,802,075	111,816	8,913,891
1928.....	14,069,357	294,839	14,364,196

Nickel imported for consumption in the United States, 1927 and 1928, by classes

Class	1927		1928	
	Pounds	Value	Pounds	Value
Unmanufactured:				
Nickel ore and matte.....	10,744,474	\$902,272	18,589,032	\$1,469,717
Nickel alloys, pigs, bars, etc.....	29,219,779	7,720,885	48,995,620	12,346,337
Nickel oxide.....	1,013,332	178,803	1,743,218	252,891
Nickel silver or German silver.....	232	115	2,803	412
Manufactured:				
Nickel silver or German silver in sheets, strips, and rods.....	16,522	12,047	22,750	11,101
All other manufactures of nickel.....		99,769		283,738
		8,913,891		14,364,196

Nickel, nickel oxide, and matte exported from the United States, 1919-1923¹

Year	Pounds	Value	Year	Pounds	Value
1919.....	3,810,656	\$1,697,544	1922.....	9,317,520	\$1,016,091
1920.....	1,215,232	574,845	1923 ²	11,200	626
1921.....	425,851	103,372			

¹ Not separately classified after 1923.² Nickel oxide and matte only. Separate figures for nickel not available.*Nickel exported from the United States, 1927 and 1928, by classes*

Class	1927		1928	
	Pounds	Value	Pounds	Value
Nickel.....	2,108,435	\$601,182	2,349,269	\$879,939
Monel metal and other alloys.....		787,767	(¹)	1,160,626
Manufactures.....		319,059	1,404,549	364,138
Nickel silver or German silver in bars, rods, or sheets.....	1,424,268			

¹ Quantity not recorded.**OILSTONES AND SCYTHESTONES**

[See Abrasive materials]

ORE

Crude metallic ores (including tailings, etc.) shipped from or treated at the mine in the United States, 1924-1928, in short tons

[Figures rounded]

Class of ore	1924	1925	1926	1927	1928
Aluminum ore (bauxite).....	389,000	355,000	439,000	359,000	420,000
Chromite.....	320	120	160	220	740
Dry and siliceous (gold and silver) ore.....	8,979,000	8,995,000	8,743,000	8,550,000	8,095,000
Iron ore ¹	58,298,000	71,557,000	77,550,000	68,561,000	71,036,000
Manganese ore (35 per cent or more Mn) ¹	63,000	110,000	52,000	50,000	52,000
Manganiferous ore (5 to 35 per cent Mn) ¹	978,000	1,591,000	1,344,000	1,633,000	1,317,000
Mercury ore.....	70,000	65,000	51,000	(?)	(?)
Copper ore:					
Western States.....	43,344,000	45,430,000	49,356,000	48,106,000	53,930,000
Central States.....	5,373,000	7,037,000	7,642,000	8,046,000	7,362,000
Eastern States.....	715,000	795,000	638,000	674,000	833,000
	49,432,000	53,262,000	57,636,000	56,826,000	62,125,000
Copper-lead and copper-lead-zinc ore.....	220,000	229,000	282,000	419,000	351,000
Lead ore:					
Western States.....	2,359,000	2,271,000	2,024,000	2,005,000	1,687,000
Central States.....	6,205,000	6,287,000	6,330,000	6,344,000	6,361,000
Eastern States.....	5,000	2,000	4,000	-----	-----
	8,569,000	8,560,000	8,358,000	8,349,000	8,048,000
Lead-zinc ore:					
Western States.....	1,792,000	2,704,000	3,461,000	3,135,000	3,583,000
Central States.....	11,493,000	14,917,000	15,488,000	11,310,000	9,796,000
Eastern States.....	71,000	120,000	144,000	202,000	-----
	13,356,000	17,741,000	19,093,000	14,647,000	13,379,000
Zinc ore:					
Western States.....	146,000	169,000	215,000	452,000	161,000
Central States.....	1,639,000	1,674,000	2,806,000	5,177,000	4,350,000
Eastern States.....	1,375,000	1,568,000	1,118,000	1,194,000	1,344,000
	3,160,000	3,411,000	4,139,000	6,823,000	5,855,000
Grand total.....	143,514,000	165,876,000	177,687,000	166,217,000	170,679,000

¹ Exclusive of fluxing ore.

² Figures not available.

PEAT

Peat produced in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	69,197	\$705,532	1924.....	55,469	\$395,470
1920.....	73,204	921,732	1925.....	72,436	452,898
1921.....	30,406	260,119	1926.....	61,936	364,413
1922.....	60,680	397,729	1927.....	(1)	(1)
1923.....	61,355	376,834	1928.....	(1)	(1)

¹ No canvass.

Peat moss imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	464	\$16,345	1924.....	5,541	\$47,208
1920.....	2,762	36,201	1925.....	10,233	121,719
1921.....	3,450	22,754	1926.....	16,669	174,241
1922.....	4,805	33,034	1927.....	31,595	326,549
1923.....	5,973	43,184	1928.....	40,087	422,275

PETROLEUM AND PETROLEUM PRODUCTS

CRUDE PETROLEUM

Crude petroleum produced in the United States, 1919-1928

[Barrels of 42 U. S. gallons]

Year	Barrels	Value at wells	Year	Barrels	Value at wells
1919.....	378,367,000	\$760,266,000	1924.....	713,940,000	\$1,022,683,000
1920.....	442,929,000	1,360,745,000	1925.....	763,743,000	1,284,960,000
1921.....	472,183,000	814,745,000	1926.....	770,874,000	1,447,760,000
1922.....	557,531,000	895,111,000	1927.....	901,129,000	1,172,830,000
1923.....	732,407,000	978,430,000	1928.....	901,474,000	1,054,880,000

Crude petroleum produced in the United States, 1927 and 1928, by fields and States

	1927		1928	
	Barrels	Value at wells	Barrels	Value at wells
FIELD				
Appalachian.....	30,454,000	\$76,880,000	31,059,000	\$82,320,000
Lima-Indiana.....	1,835,000	3,260,000	1,670,000	2,630,000
Illinois and southwestern Indiana.....	7,720,000	12,900,000	7,425,000	11,450,000
Michigan.....	439,000	832,000	594,000	920,000
Mid-Continent.....	546,987,000	708,940,000	553,125,000	634,553,000
Gulf coast.....	52,069,000	67,250,000	46,591,000	55,150,000
Rocky Mountain ¹	30,429,000	42,033,000	29,199,000	37,860,000
California.....	231,196,000	260,735,000	231,811,000	230,000,000
Other fields ²	(¹)	(¹)	(¹)	(¹)
	901,129,000	1,172,830,000	901,474,000	1,054,880,000
STATE				
Alaska.....	³ 7,000	³ 33,000	³ 6,000	³ 30,000
Arkansas.....	40,005,000	42,400,000	32,096,000	27,450,000
California.....	231,196,000	260,735,000	231,811,000	230,000,000
Colorado.....	2,831,000	3,400,000	2,774,000	2,750,000
Illinois.....	6,994,000	11,700,000	6,462,000	9,980,000
Indiana.....	852,000	1,390,000	1,052,000	1,580,000
Kansas.....	41,069,000	58,300,000	38,596,000	52,500,000
Kentucky.....	6,719,000	11,220,000	7,359,000	11,850,000
Louisiana.....	22,818,000	29,740,000	21,847,000	25,850,000
Michigan.....	439,000	832,000	594,000	920,000
Montana.....	5,058,000	7,090,000	4,015,000	6,400,000
New Mexico.....	1,226,000	1,680,000	943,000	1,280,000
New York.....	2,242,000	7,110,000	2,603,000	8,750,000
Ohio.....	7,593,000	14,970,000	7,015,000	14,470,000
Oklahoma.....	277,775,000	397,200,000	249,857,000	347,600,000
Pennsylvania.....	9,526,000	29,150,000	9,956,000	32,550,000
Tennessee.....	60,000	90,000	46,000	70,000
Texas.....	217,389,000	248,550,000	257,320,000	236,300,000
Utah.....	(³)	(³)	(³)	(³)
West Virginia.....	6,023,000	17,410,000	5,661,000	17,150,000
Wyoming.....	21,307,000	29,830,000	21,461,000	27,400,000
	901,129,000	1,172,830,000	901,474,000	1,054,880,000

¹ Production of Alaska included with Rocky Mountain.² Alaska.³ Utah included with Alaska.

*Stocks of crude petroleum held in the United States on December 31, 1927 and 1928,
in barrels*

	1927	1928
East of California:		
At refineries, by location of storage—		
East coast—		
Domestic.....	8,690,000	8,496,000
Foreign.....	2,768,000	4,306,000
Appalachian.....	1,871,000	2,183,000
Indiana, Illinois, Kentucky, etc.....	2,777,000	2,939,000
Oklahoma, Kansas, and Missouri.....	4,871,000	5,530,000
Texas—		
Inland.....	1,432,000	2,184,000
Gulf coast—		
Domestic.....	7,686,000	7,206,000
Foreign.....	219,000	207,000
Arkansas and inland Louisiana.....	408,000	758,000
Louisiana, Gulf coast—		
Domestic.....	6,149,000	3,315,000
Foreign.....	1,046,000	1,359,000
Rocky Mountain.....	1,400,000	2,046,000
Total at refineries.....	39,317,000	40,529,000
Pipe-line and tank-farm stocks—		
Domestic petroleum, by field of origin—		
Appalachian—		
New York, Pennsylvania, West Virginia, eastern and central/gross..	6,621,000	5,036,000
Ohio.....net.....	6,294,000	4,751,000
Kentucky.....gross.....	1,168,000	913,000
.....net.....	1,040,000	764,000
Lima-Indiana.....gross.....	1,287,000	1,344,000
.....net.....	1,134,000	1,162,000
Illinois-southwestern Indiana.....gross.....	12,664,000	12,035,000
.....net.....	12,170,000	11,367,000
Mid-Continent—		
Oklahoma, Kansas, north, central, western, and Panhandle/gross..	234,420,000	251,849,000
Texas.....net.....	221,466,000	239,345,000
North Louisiana and Arkansas.....gross.....	28,174,000	29,131,000
.....net.....	25,373,000	26,403,000
Gulf coast.....gross.....	18,365,000	18,826,000
.....net.....	17,922,000	18,272,000
Rocky Mountain.....gross.....	27,281,000	25,522,000
.....net.....	27,238,000	25,501,000
Total pipe-line and tank-farm.....gross.....	329,980,000	344,656,000
.....net.....	312,637,000	327,565,000
Foreign crude petroleum held in United States by importers—		
At Atlantic coast stations.....	46,000	49,000
At Gulf coast stations.....	38,000	210,000
Total.....	84,000	259,000
Producers' stocks.....	7,536,000	6,521,000
Total crude stocks east of California.....	359,574,000	374,874,000
California.....	113,805,000	115,914,000
Grand total.....	473,379,000	490,788,000

*Indicated deliveries of crude petroleum (exclusive of California grades) to consumers
in the United States, 1927 and 1928, in barrels¹*

	1927	1928
Domestic petroleum (by field of origin):		
Appalachian.....	30,915,000	32,908,000
Lima-Indiana.....	1,366,000	1,649,000
Michigan.....	435,000	595,000
Illinois and southwestern Indiana.....	7,317,000	8,232,000
Mid-Continent.....	471,941,000	534,951,000
Gulf coast.....	54,479,000	46,331,000
Rocky Mountain ²	31,391,000	31,084,000
Deliveries and exports.....	597,844,000	655,750,000
Exports.....	10,587,000	13,284,000
Deliveries.....	587,257,000	642,466,000
Foreign petroleum.....	58,908,000	79,591,000
	646,165,000	722,057,000

¹ Indicated deliveries equal production plus imports plus stocks, exclusive of refinery stocks, at beginning of period minus exports and stocks at end of period.

² Alaska included with Rocky Mountain.

Crude petroleum imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports			
	Barrels	Value	Domestic petroleum		Foreign petroleum ¹	
			Barrels	Value	Barrels	Value
1919.....	52,821,567	\$26,442,881	5,924,320	\$14,805,546	94,331	\$42,520
1920.....	106,175,289	55,799,254	8,044,907	25,990,444	712,185	996,430
1921.....	125,363,983	66,547,379	8,865,497	20,204,491	74,136	57,407
1922.....	127,308,423	70,383,309	9,995,093	18,348,110	167,724	74,121
1923.....	82,015,025	53,882,259	17,060,771	23,111,832	324,607	150,358
1924.....	77,775,173	73,841,507	17,604,877	26,495,011	367,662	165,401
1925.....	61,824,242	75,406,956	13,125,157	24,274,905	209,950	94,372
1926.....	60,382,329	79,307,877	15,406,045	28,495,773	1,353	4,436
1927.....	58,382,632	78,609,117	15,843,405	25,944,489	241	333
1928.....	79,766,672	90,472,376	18,961,362	26,786,248	995	1,618

¹ Exports of refined products and shipments of crude petroleum to Alaska, Hawaii, Porto Rico, and the Philippine Islands are not included.

PETROLEUM PRODUCTS

Crude petroleum run to stills and chief petroleum products produced at refineries in the United States, 1919-1928, in barrels

Year	Crude petroleum run to stills		Chief petroleum products			
	Domestic	Foreign	Gasoline	Kerosene	Gas oil and fuel oil	Lubricants
1919.....	361,520,000		94,235,000	55,753,000	181,602,000	20,161,000
1920.....	433,915,000		116,251,000	55,240,000	210,987,000	24,938,000
1921.....	443,363,000		122,704,000	46,313,000	230,091,000	20,896,000
1922.....	425,823,000	74,883,000	147,672,000	54,913,000	254,910,000	23,304,000
1923.....	538,252,000	42,986,000	179,903,000	55,927,000	287,481,000	26,128,000
1924.....	597,954,000	45,765,000	213,326,000	60,026,000	320,476,000	27,498,000
1925.....	698,582,000	41,338,000	259,601,000	59,689,000	364,991,000	31,055,000
1926.....	734,301,000	44,963,000	299,734,000	61,768,000	365,195,000	32,293,000
1927.....	778,729,000	50,106,000	330,435,000	56,113,000	393,066,000	31,721,000
1928.....	835,711,000	77,584,000	376,945,000	59,353,000	427,237,000	34,658,000

Chief petroleum products imported for consumption in the United States, 1919-1928, in barrels

Year	Gasoline	Kerosene	Gas oil and fuel oil	Lubricants
1919.....	202,861	(1)	(1)	(1)
1920.....	963,764	(1)	(1)	(1)
1921.....	900,381	(1)	(1)	(1)
1922.....	1,479,349	¹ 3,487	² 2,947,102	³ 43,057
1923.....	4,555,084	7,178	12,286,260	29,027
1924.....	3,452,923	9,942	12,926,837	10,761
1925.....	3,812,790	19,281	12,245,468	37,475
1926.....	5,539,585	74,097	14,432,175	33,018
1927.....	5,002,306	55,435	8,124,192	7,944
1928.....	4,197,708	201,745	7,268,147	12,654

¹ Not separately classified prior to Sept. 22, 1922.

² Figures cover Sept. 22 to Dec. 31, 1922; not separately classified prior to change in tariff.

Chief petroleum products exported from the United States, 1919-1928, in barrels

Year	Gasoline	Kerosene	Gas oil and fuel oil	Lubricants
1919.....	8,860,309	23,313,218	13,924,991	6,542,742
1920.....	15,269,280	20,730,120	19,704,625	9,574,320
1921.....	12,692,270	17,832,693	20,120,493	6,888,491
1922.....	13,787,191	21,315,015	16,600,462	7,889,516
1923.....	20,135,567	20,188,796	29,252,245	8,295,726
1924.....	28,246,078	21,817,890	34,292,709	9,030,944
1925.....	30,637,804	21,074,667	32,508,547	9,596,484
1926.....	42,479,876	22,016,214	34,516,390	9,265,781
1927.....	43,334,164	19,352,102	42,963,180	9,686,361
1928.....	51,751,754	21,846,633	41,573,185	10,933,160

PHOSPHATE ROCK

Phosphate rock sold or used by producers in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919.....	2,271,983	\$11,591,268	1924.....	2,867,789	\$10,252,083
1920.....	4,103,982	25,079,572	1925.....	3,481,819	11,545,678
1921.....	2,064,025	12,270,070	1926.....	3,209,976	10,893,800
1922.....	2,417,883	10,482,846	1927.....	3,170,699	11,253,352
1923.....	3,006,706	11,576,049	1928.....	3,501,406	12,443,179

Phosphate rock imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Long tons	Value	Long tons	Value
1919.....	34	\$457	378,731	\$3,567,982
1920.....	63	2,090	1,069,712	10,570,175
1921.....	3,535	43,960	733,312	7,320,137
1922.....	5,890	95,846	719,294	5,858,167
1923.....	6,725	92,263	827,551	5,772,171
1924.....	16,098	181,515	818,773	5,120,832
1925.....	2,735	37,932	870,200	5,677,763
1926.....	17,378	192,611	748,963	4,435,590
1927.....	28,195	292,871	918,211	4,731,562
1928.....	45,812	431,238	898,764	4,453,101

PLATINUM AND ALLIED METALS

Reports received from refiners of crude platinum, gold bullion, and copper indicate that 59,039 troy ounces of refined new metals of the platinum group were recovered in 1928, of which 9,590 ounces are believed to be of domestic origin.

New platinum and allied metals recovered by refiners in the United States, 1919-1928, in troy ounces

Year	Platinum	Palladium	Iridium	Osmiridium	Other	Total
1919.....	40,220	3,807	401	402	279	45,109
1920.....	36,015	4,309	418	400	393	41,544
1921.....	51,791	2,686	286	581	1,026	56,370
1922.....	54,142	1,943	210	1,301	122	57,718
1923.....	46,780	1,934	280	787	16	49,797
1924.....	57,827	6,065	680	1,261	174	66,007
1925.....	41,300	7,358	283	648	54	49,643
1926.....	76,154	6,437	234	2,113	43	84,981
1927.....	41,121	3,879	256	631	163	46,050
1928.....	51,427	5,148	1,658	458	348	59,039

Dealers and refiners reported recovery in 1928 of 55,831 ounces of secondary platinum metals derived from refining scrap metal, sweeps, and other waste products of manufacture that contain platinum. Although the figures that make up this total undoubtedly contain some duplication, it is believed that they are worth publishing.

Secondary platinum and allied metals recovered in the United States, 1919-1928, in troy ounces

Year	Platinum	Palladium	Iridium	Other	Total
1919-----	54,545	3,467	3,504	-----	61,516
1920-----	51,255	3,100	3,355	-----	57,710
1921-----	39,131	4,887	1,776	229	46,023
1922-----	40,062	4,193	1,937	496	46,688
1923-----	39,152	6,246	2,021	453	47,872
1924-----	45,474	5,784	2,200	1,013	54,471
1925-----	35,578	4,680	1,827	1,189	43,274
1926-----	38,795	5,647	1,478	217	46,137
1927-----	46,127	4,244	1,810	891	53,072
1928-----	47,157	4,156	2,090	2,428	55,831

Platinum and allied metals imported for consumption in the United States, 1919-1928

Year	Troy ounces	Value	Year	Troy ounces	Value
1919-----	68,054	\$6,747,447	1924-----	111,359	\$11,030,349
1920-----	100,546	10,617,440	1925-----	125,802	13,230,148
1921-----	78,378	5,418,464	1926-----	134,797	13,451,835
1922-----	110,025	8,983,547	1927-----	148,769	12,413,494
1923-----	106,637	10,466,705	1928-----	135,233	9,357,737

Platinum and allied metals imported for consumption in the United States, 1927 and 1928, by metals

Metal	1927		1928	
	Troy ounces	Value	Troy ounces	Value
Platinum:				
Ores of platinum metals (platinum content)-----			686	\$49,094
Grains, nuggets, sponge, or scrap-----	90,491	\$7,480,869	78,399	5,298,665
Ingots, bars, sheets or plates, not less than one-eighth inch thick-----	38,053	3,707,062	29,362	2,348,840
Manufactures of, except jewelry-----	128,544	11,187,931	108,447	7,696,599
Iridium-----	37	5,812	39	3,146
Osmiridium-----	4,633	520,202	4,212	672,384
Osmium-----	7,506	397,408	5,785	418,829
Palladium-----	6	277	310	20,337
Rhodium-----	6,251	222,878	13,463	407,826
Ruthenium-----	1,308	59,940	1,887	102,120
	484	19,046	1,090	36,496
	148,769	12,413,494	135,233	9,357,737

Platinum exported from the United States, 1919-1928

Year	Unmanufactured		Manufactures of, except jewelry	
	Troy ounces	Value	Troy ounces	Value
1919.....	522	\$75,066	(¹)	\$54,529
1920.....	1,302	177,115	(¹)	111,014
1921.....	3,272	244,473	741	85,216
1922.....	143	13,149	486	35,967
1922 {Crude, scrap, and old Ingots, sheets, wire, and alloys.....	1,313	127,047		
1923.....	1,151	128,599	592	65,073
1924.....	5,854	643,282	1,274	136,948
1925.....	16,234	1,787,122	3,537	249,975
1926.....	11,573	1,253,795	1,898	160,648
1927.....	19,923	1,577,560	1,549	128,875
1928.....	9,050	619,478	2,168	160,554

¹ Quantity not recorded.**POTASH***Crude potassium salts produced and sold in the United States, 1919-1928*

Year	Produced			Sold		
	Number of plants	Gross weight (short tons)	K ₂ O equivalent (short tons)	Gross weight (short tons)	K ₂ O equivalent (short tons)	Value f. o. b. plant
1919.....	102	116,634	32,474	166,063	45,728	\$11,271,269
1920.....	66	166,834	48,077	139,963	41,444	7,463,026
1921.....	20	25,485	10,171	10,337	4,408	447,859
1922.....	12	25,176	11,714	22,028	11,313	463,512
1923.....	12	39,029	20,215	35,164	19,281	784,671
1924.....	12	43,734	22,903	37,492	21,880	842,618
1925.....	9	51,565	25,448	52,823	25,802	1,204,024
1926.....	7	46,324	23,366	51,369	25,060	1,063,064
1927.....	9	76,819	43,510	94,722	49,500	2,448,146
1928.....	9	104,129	59,910	105,208	60,370	3,029,422

Potash materials imported for consumption in the United States, 1919-1928

Year	Potassium salts used mainly in the fertilizer industry ¹			Potassium salts used mainly in chemical industries ²			Total		
	Short tons		Value	Short tons		Value	Short tons		Value
	Gross weight	K ₂ O equivalent (approximate)		Gross weight	K ₂ O equivalent (approximate)		Gross weight	K ₂ O equivalent (approximate)	
1919.....	127,416	28,484	\$4,163,739	33,430	11,135	\$5,028,077	160,846	39,619	\$10,191,816
1920.....	918,698	197,795	33,885,627	63,564	26,997	9,504,156	982,262	224,792	43,389,783
1921.....	212,752	64,126	7,743,364	32,453	14,572	3,739,090	245,205	78,698	11,482,454
1922.....	632,711	186,264	10,951,197	34,198	15,151	4,415,891	666,909	201,415	15,367,088
1923.....	712,701	194,210	10,633,475	35,824	15,740	4,771,097	748,525	209,050	15,404,572
1924.....	663,914	187,079	10,042,575	28,336	13,286	3,325,552	692,250	200,365	13,368,127
1925.....	892,684	239,167	12,730,019	44,429	19,050	4,641,747	937,113	258,217	17,371,766
1926.....	859,422	245,700	13,635,154	47,941	20,580	4,796,711	907,363	266,280	18,431,865
1927.....	687,349	225,000	13,178,610	43,248	19,155	5,191,195	730,597	244,155	18,369,805
1928.....	931,616	310,000	18,227,830	44,045	20,493	4,202,162	975,661	330,493	22,519,992

¹ Includes kainite, manure salts, muriate, and sulphate. Considerable quantities of muriate and some sulphate were used in chemical industries.² Includes bicarbonate, bichromate, bitartrate, bromide, carbonate, caustic, chloride, chromate, cyanide, ferrieyanide, ferroeyanide, iodide, nitrate, perchlorate, permanganate, and Rochelle salt.

Domestic potassium salts exported from the United States, 1919-1928

Year	Gross weight (short tons)	Value	Year	Gross weight (short tons)	Value
1919.....	(1)	\$2,755,544	1924.....	1,923	\$301,036
1920.....	(1)	3,562,015	1925.....	2,155	398,740
1921.....	(1)	335,993	1926.....	1,679	319,201
1922.....	6,238	780,996	1927.....	1,965	487,726
1923.....	3,997	505,837	1928.....	2,619	609,018

¹ Figures not available.**PUMICE**

[See Abrasive materials]

PYRITES*Pyrites produced in the United States, 1919-1928*

Year	Long tons	Value	Year	Long tons	Value
1919.....	420,647	\$2,558,172	1924.....	160,096	\$645,262
1920.....	310,777	1,596,961	1925.....	170,081	650,448
1921.....	157,118	711,432	1926.....	166,559	616,668
1922.....	169,043	671,241	1927.....	215,786	804,006
1923.....	181,628	661,000	1928.....	182,049	605,459

Pyrites containing more than 25 per cent of sulphur imported for consumption in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919.....	388,973	\$2,176,565	1924.....	246,737	\$598,544
1920.....	332,606	1,660,832	1925.....	276,385	773,925
1921.....	216,229	818,852	1926.....	366,151	856,981
1922.....	279,445	1,199,076	1927.....	250,794	647,512
1923.....	263,695	1,254,389	1928.....	457,123	1,135,463

Exports of "pyrites or other sulphur ore" in 1922 amounted to 323 long tons, valued at \$4,325. Data for other years are not separately shown.

QUARTZ

[See under Silica]

QUICKSILVER

[See Mercury]

RADIUM

[See Uranium and vanadium ores]

RUTILE

[See Titanium minerals]

SALT

Salt sold or used by producers in the United States, 1919-1928

Year	Short tons				Total value
	Manufactured (evaporated)	In brine	Rock salt	Total	
1919.....	2,392,290	2,850,639	1,639,973	6,882,902	\$27,074,694
1920.....	2,409,924	2,819,916	1,610,189	6,840,029	29,894,075
1921.....	1,931,243	1,577,335	1,472,576	4,981,154	24,557,966
1922.....	2,276,683	2,569,042	1,947,124	6,792,849	27,464,838
1923.....	2,239,872	2,787,239	2,103,602	7,130,713	27,795,941
1924.....	2,224,555	2,513,853	2,064,707	6,803,115	25,747,048
1925.....	2,235,170	2,819,690	2,342,640	7,397,500	26,162,361
1926.....	2,198,060	3,037,820	2,135,720	7,371,600	25,055,012
1927.....	2,263,030	3,161,800	2,143,860	7,568,690	24,817,962
1928.....	2,430,050	3,426,870	2,217,780	8,074,700	26,772,568

Salt sold or used by producers in the United States, 1927 and 1928, by States

State	1927		1928	
	Short tons	Value	Short tons	Value
California.....	300,880	\$1,827,750	383,730	\$2,292,296
Kansas.....	794,780	2,971,544	821,950	3,573,982
Louisiana.....	606,110	2,167,220	630,780	2,405,351
Michigan.....	2,271,460	7,551,552	2,405,240	8,249,437
New York.....	1,964,080	6,121,461	2,085,230	6,400,933
Ohio.....	1,203,170	3,130,236	1,308,110	2,988,862
Porto Rico.....	15,150	28,920		
Texas.....	54,270	399,171	(1)	(1)
Utah.....	74,690	334,732	85,800	193,582
West Virginia.....	22,600	167,155	18,700	149,421
Undistributed ¹	261,500	118,221	335,160	518,704
	7,568,690	24,817,962	8,074,700	26,772,568

¹ Included under "Undistributed."² 1927: Arizona, Nevada, New Mexico, Oklahoma, and Virginia; 1928: Arizona, Nevada, New Mexico, Oklahoma, Texas, and Virginia.*Salt imported into and exported from the United States, 1919-1928*

Year	Imports for consumption		Exports	
	Short tons	Value	Short tons	Value
1919.....	59,514	\$242,704	119,416	\$1,396,625
1920.....	137,654	676,499	139,272	1,901,593
1921.....	93,095	531,031	109,563	1,415,471
1922.....	113,922	522,338	134,989	1,429,172
1923.....	88,750	383,258	125,529	1,211,226
1924.....	88,938	324,092	144,945	1,288,376
1925.....	85,788	316,827	155,079	1,219,935
1926.....	55,964	202,243	158,908	1,277,790
1927.....	44,968	167,675	153,832	1,329,980
1928.....	42,856	149,559	145,396	1,185,682

SAND AND GRAVEL

Sand and gravel sold or used by producers in the United States, 1919-1928

Year	Glass sand		Molding sand		Building sand	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	1,827,409	\$3,593,371	3,774,612	\$4,153,990	21,969,736	\$12,296,664
1920.....	2,165,926	4,748,690	5,128,075	7,504,759	26,539,365	17,956,635
1921.....	1,280,359	2,314,314	1,906,977	2,451,966	24,565,605	16,053,413
1922.....	1,768,549	2,866,366	3,839,116	4,478,405	29,375,466	17,574,579
1923.....	2,034,958	3,751,778	5,559,644	6,730,417	39,234,762	23,751,244
1924.....	2,169,899	3,718,973	4,403,893	4,995,268	41,376,425	23,455,393
1925.....	2,334,921	3,836,085	4,995,428	5,400,618	45,287,240	26,306,463
1926.....	2,274,218	3,615,371	5,309,166	5,630,799	45,327,512	24,891,475
1927.....	2,171,693	3,257,790	4,194,975	4,458,508	40,737,377	22,198,767
1928.....	2,310,828	3,435,645	4,781,765	5,089,969	45,629,207	24,116,772

Year	Other sand		Gravel		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	8,397,979	\$6,345,654	34,606,671	\$19,561,877	70,576,407	\$45,951,556
1920.....	9,942,776	8,988,530	38,265,246	26,462,991	82,041,388	65,661,605
1921.....	10,542,013	8,230,257	41,550,054	27,434,295	79,845,008	56,484,245
1922.....	14,711,792	10,550,570	45,172,123	29,147,744	94,867,046	64,617,664
1923.....	20,535,907	14,240,126	72,566,882	42,430,089	139,932,153	90,903,654
1924.....	27,621,793	16,674,831	80,658,053	48,168,650	156,230,063	97,013,115
1925.....	34,564,633	19,605,159	84,819,251	52,393,798	172,001,473	107,542,123
1926.....	39,203,383	21,538,343	90,986,539	55,662,713	183,100,818	111,338,701
1927.....	46,484,294	24,376,333	103,865,930	61,238,388	197,454,269	115,529,786
1928.....	45,015,917	23,490,020	111,381,151	63,075,531	209,118,868	119,207,937

Sand and gravel imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Short tons	Value	Short tons	Value
1919.....	597,481	\$126,586	(1)	\$382,070
1920.....	1,226,684	912,282	(1)	669,945
1921.....	906,905	771,734	(1)	379,982
1922.....	2 451,943	2 238,386	356,520	400,199
1923.....	2 477,762	2 259,820	551,233	598,633
1924.....	2 701,410	2 280,206	314,140	401,662
1925.....	2 534,555	2 233,422	425,612	496,050
1926.....	2 947,579	2 341,911	424,374	610,023
1927.....	2 736,271	2 302,551	421,243	557,644
1928.....	2 788,222	2 392,111	737,368	638,268

¹ Quantities not recorded prior to 1922.² Includes 65,848 tons of gravel, valued at \$27,434, and 1,290 tons of glass sand, valued at \$1,112, imported after change in tariff Sept. 22. Not separately shown prior to that time.³ Includes: 1923, 198,960 tons of gravel, valued at \$99,687, and 2,309 tons of glass sand, valued at \$3,008; 1924, 448,586 tons, \$155,146, and 6,479 tons, \$1,961; 1925, 224,600 tons, \$89,505, and 4,186 tons, \$2,262; 1926, 239,476 tons, \$90,226, and 8,817 tons, \$9,091; 1927, 313,809 tons, \$104,312, and 10,665 tons, \$8,712; and 1928, 359,237 tons, \$167,350, and 43,137 tons, \$35,689, respectively.

SAND-LIME BRICK

*Sand-lime brick sold in the United States, 1919-1928*¹

Year	Number of operators	Thousands	Value	Year	Number of operators	Thousands	Value
1919.....	35	146,947	\$1,705,163	1924 ²	37	283,417	\$3,334,503
1920.....	37	169,761	2,490,283	1925 ²	42	315,595	3,780,639
1921 ²	26	97,126	1,268,502	1926 ²	42	330,586	3,981,492
1922.....	(1)	(1)	(1)	1927 ²	47	319,618	3,645,842
1923 ²	33	213,425	2,471,536	1928 ²	41	313,553	3,654,590

¹ Canvass discontinued by U. S. Geological Survey after 1920. No canvass for 1922.² According to Bureau of the Census. Figures represent production.

Imports of sand-lime brick were not reported separately until 1924. The figures for 1924 are 22,426,000 brick, valued at \$129,042; for 1925, 148,000 brick, \$1,004; for 1926, 3,095,000 brick, \$28,748; for 1927, none; and for 1928, 1,707,000 brick, \$8,628.

Exports are not reported separately.

SELENIUM

Most of the selenium produced is a by-product in the electrolytic refining of copper.

Selenium, produced in the United States, sold in 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	60,025	\$125,966	1924.....	153,762	\$286,066
1920.....	92,141	175,508	1925.....	194,007	330,637
1921.....	55,978	89,148	1926.....	252,312	438,132
1922.....	123,565	177,542	1927.....	284,508	491,996
1923.....	127,174	237,196	1928.....	362,697	607,382

Selenium and selenium salts imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	(1)	\$25,866	1924.....	300	\$606
1920.....			1925.....	5,807	10,582
1921.....	1,106	2,099	1926.....	18,885	34,680
1922.....	1,652	2,530	1927.....	15,286	28,199
1923.....	940	1,653	1928.....	18,622	33,998

¹ Total quantity not recorded.

Exports of selenium are not separately recorded.

SILICA

Quartz sold or used by producers in the United States, 1919-1928

Year	Crude		Ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	51,774	\$135,187	11,558	\$238,384	63,332	\$373,571
1920.....	59,423	142,397	8,767	177,953	68,190	320,350
1921.....	8,570	39,660	2,682	45,297	11,252	84,957
1922.....	5,085	23,093	5,568	78,254	10,653	101,347
1923.....	14,159	66,723	6,442	126,907	20,601	193,630
1924.....	20,570	123,099	3,191	80,078	23,761	203,177
1925.....	22,312	143,861	3,132	61,515	25,444	205,376
1926.....	22,230	159,052	5,513	115,281	27,743	274,333
1927.....	18,504	124,021	3,640	70,019	22,144	194,040
1928.....	15,363	79,229	6,835	130,104	22,198	209,333

Silica sold or used by producers in the United States for pottery, paints, fillers, polishers, abrasives, and other uses, 1927 and 1928

Material	1927		1928	
	Short tons	Value	Short tons	Value
Quartz (vein quartz, pegmatite, and quartzite).....	22,144	\$194,040	22,198	\$209,333
Sand and sandstone ¹	275,737	1,897,303	280,402	1,966,296
Tripoli (including rottenstone) (ground and otherwise prepared).....	26,099	447,068	34,043	555,576
Diatomite.....	(2)	(2)	(2)	(2)
	(2)	(2)	(2)	(2)

¹ Includes only finely ground material. Figures probably incomplete.

² Bureau of Mines not at liberty to publish figures for diatomite.

Imports of "crude silica" have been as follows: 1928, none; 1927, 12 short tons, valued at \$175; 1926, 27 tons, \$149; 1925, 22 tons, \$486; 1924, 12 tons, \$254; and 1923, 34 tons, \$550. Similar imports were not recorded prior to September 22, 1922, but from that date to the end of the year 1 ton, valued at \$45, was imported. Imports of "silica for use as pigment" have been recorded as follows: 1928, none; 1927, 22 short tons, valued at \$535; similar imports not separately recorded for earlier years. The Bureau of Foreign and Domestic Commerce records imports of "flint, flints, and flint stones, unground," from several countries. These imports are partly flint pebbles for use in grinding mills and partly material for uses such as are listed above. The figures can not be accurately separated.

"Flint, flints, and flint stones, unground" imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	19,798	\$250,096	1924.....	17,473	\$114,958
1920.....	20,636	338,630	1925.....	16,240	105,041
1921.....	10,084	116,157	1926.....	15,091	120,078
1922.....	16,040	145,805	1927.....	15,191	93,558
1923.....	15,952	130,974	1928.....	15,719	144,313

No exports of silica are reported.

SILVER

[See under Gold and silver]

SLATE

Slate sold by producers in the United States, 1919-1928, by uses

Year	Roofing slate		Mill stock		Slate for other uses ¹	Total value
	Number of squares (100 square feet)	Value	Square feet	Value		
1919.....	454, 337	\$3, 085, 957	7, 466, 000	\$1, 782, 793	\$1, 161, 898	\$6, 030, 648
1920.....	396, 230	3, 524, 658	9, 910, 000	3, 147, 281	2, 054, 503	8, 726, 442
1921.....	348, 085	3, 197, 745	8, 970, 000	2, 719, 723	1, 404, 538	7, 322, 006
1922.....	479, 243	4, 069, 761	9, 276, 800	2, 899, 195	2, 207, 828	9, 176, 784
1923.....	507, 587	4, 582, 535	11, 109, 480	4, 159, 644	3, 334, 445	12, 076, 624
1924.....	469, 393	4, 626, 614	10, 009, 180	3, 922, 366	3, 227, 036	11, 776, 016
1925.....	494, 530	5, 084, 945	11, 077, 860	4, 231, 477	3, 258, 904	12, 575, 326
1926.....	465, 900	5, 079, 087	10, 278, 130	4, 191, 185	3, 082, 495	12, 352, 767
1927.....	468, 560	4, 949, 940	9, 287, 680	3, 519, 386	2, 911, 410	11, 380, 736
1928.....	483, 280	5, 411, 332	9, 220, 170	3, 408, 304	2, 652, 655	11, 472, 291

¹ Chiefly slate granules.*Value of slate sold by producers in the United States, 1924-1928, by States*

State	1924	1925	1926	1927	1928
California.....	(1)	-----	\$2, 976	(1)	(1)
Maine.....	\$667, 541	\$604, 062	662, 184	\$549, 952	\$551, 242
Maryland.....	117, 137	210, 148	207, 989	205, 812	187, 830
New York.....	962, 276	851, 715	913, 814	802, 437	1, 052, 363
Pennsylvania.....	5, 157, 868	5, 885, 179	5, 413, 177	4, 769, 432	4, 786, 355
Vermont.....	4, 010, 346	3, 963, 025	4, 267, 041	4, 108, 911	3, 981, 928
Virginia.....	² 336, 627	² 377, 082	² 331, 651	² 398, 612	² 458, 153
Undistributed ³	⁴ 524, 221	⁴ 684, 115	⁴ 553, 935	⁴ 545, 580	⁴ 454, 420
	11, 776, 016	12, 575, 326	12, 352, 767	11, 380, 736	11, 472, 291

¹ Included under "Undistributed."² Exclusive of value of granules, etc., which is included under "Undistributed."³ 1924 and 1927: California, Georgia, and Tennessee; 1925: Georgia, Tennessee, and Utah; 1926: Arkansas, Georgia, and Tennessee; 1928: Arkansas, California, Georgia, and Tennessee.⁴ Includes also value of granules, etc., for Virginia*Slate sold by producers in the United States, 1927 and 1928, by uses*

Use	1927		1928	
	Quantity	Value	Quantity	Value
Roofing.....squares.....	468, 560	\$4, 949, 940	483, 280	\$5, 411, 332
Approximate equivalent in short tons.....	176, 540	-----	177, 310	-----
Electrical.....square feet.....	1, 417, 060	1, 155, 502	1, 289, 060	1, 025, 386
Approximate equivalent in short tons.....	12, 420	-----	10, 990	-----
Structural and sanitary.....square feet.....	2, 420, 730	944, 577	2, 543, 470	1, 034, 818
Approximate equivalent in short tons.....	18, 760	-----	19, 990	-----
Grave vaults and covers.....square feet.....	530, 740	140, 947	532, 570	136, 836
Approximate equivalent in short tons.....	4, 920	-----	5, 060	-----
Blackboards and bulletin boards.....square feet.....	3, 735, 870	1, 116, 598	3, 713, 840	1, 079, 452
Approximate equivalent in short tons.....	10, 490	-----	9, 450	-----
Billiard table tops.....square feet.....	402, 700	141, 764	293, 360	109, 221
Approximate equivalent in short tons.....	3, 450	-----	2, 550	-----
School slates.....pieces.....	1, 459, 100	19, 998	1, 584, 820	22, 591
Approximate equivalent in square feet.....	780, 580	-----	847, 870	-----
Approximate equivalent in short tons.....	900	-----	740	-----
Granules.....short tons.....	459, 760	2, 775, 962	413, 980	2, 468, 471
Other.....short tons (estimated).....	4, 800	135, 448	6, 290	184, 184
Total (quantities approximate, in short tons).....	692, 040	11, 380, 736	646, 360	11, 472, 291

Value of slate imported for consumption in the United States, 1919-1928

1919.....	\$691	1924.....	\$32, 095
1920.....	4, 512	1925.....	64, 570
1921.....	2, 923	1926.....	86, 681
1922.....	2, 753	1927.....	78, 909
1923.....	16, 881	1928.....	44, 778

Value of roofing slate exported from the United States, 1919-1928

1919.....	\$55, 164	1924.....	\$77, 422
1920.....	122, 105	1925.....	54, 130
1921.....	101, 630	1926.....	53, 117
1922.....	97, 811	1927.....	80, 171
1923.....	78, 780	1928.....	119, 187

The following figures for exports of slate other than roofing were collected by the Bureau of Mines from shippers of the products named:

Slate other than roofing exported from the United States, 1926-1928, by uses

Use	1926		1927		1928	
	Quantity	Value	Quantity	Value	Quantity	Value
School slates.....cases ¹	11, 210	\$92, 165	8, 060	\$76, 333	14, 320	\$81, 075
Electrical slate.....square feet.....	51, 490	56, 042	25, 550	26, 916	23, 190	19, 102
Blackboards.....do.....	125, 730	47, 520	142, 650	50, 120	160, 680	63, 526
Billiard tables.....do.....	46, 730	37, 903	55, 350	37, 341	65, 620	45, 010
Structural.....do.....	39, 870	20, 800	13, 200	9, 100	14, 440	7, 741
Slate granules.....short tons.....	7, 620	46, 000	11, 360	67, 000	13, 990	82, 140
		300, 430		266, 810		298, 594

¹ Cases weigh from 130 to 165 pounds each; average is 135 pounds.

SOAPSTONE

[See Talc and soapstone]

SODIUM SALTS (NATURAL)

In addition to common salt, figures for which are given on page A71, the following quantities of other natural sodium salts (including carbonate, bicarbonate, sulphate, trona, and borate) and colemanite have been shipped by the producers.

Sodium salts (other than NaCl), derived from natural sources in the United States, shipped by producers, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	29, 120	\$874, 083	1924.....	76, 420	\$1, 825, 850
1920.....	42, 683	1, 513, 179	1925.....	73, 300	2, 095, 110
1921.....	25, 000	894, 000	1926.....	93, 480	2, 326, 750
1922.....	45, 406	1, 415, 774	1927.....	145, 770	3, 834, 324
1923.....	59, 440	1, 775, 940	1928.....	206, 380	5, 272, 228

Borates (colemanite and naturally occurring sodium borate) shipped by producers in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	66, 146	\$1, 380, 000	1924.....	116, 110	\$3, 183, 910
1920.....	120, 320	2, 173, 000	1925.....	113, 700	3, 085, 660
1921.....	50, 000	1, 600, 000	1926.....	115, 970	3, 128, 110
1922.....	85, 220	2, 705, 140	1927.....	109, 080	3, 473, 399
1923.....	136, 650	3, 994, 790	1928.....	131, 000	3, 999, 773

STEEL

[See Iron ore, pig iron, and steel]

STONE

Stone sold or used by producers in the United States, 1919-1928, by varieties

Year	Granite		Basalt and related rocks (trap rock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919..	4, 221, 220	\$19, 345, 714	7, 410, 770	\$8, 944, 686	333, 400	\$8, 042, 207	49, 759, 800	\$53, 171, 701
1920..	4, 760, 000	24, 954, 908	9, 219, 200	12, 260, 148	431, 500	11, 069, 585	59, 290, 000	75, 655, 260
1921..	4, 752, 180	20, 592, 217	8, 524, 480	11, 450, 899	315, 400	8, 580, 416	45, 621, 000	57, 749, 594
1922..	5, 913, 120	21, 125, 869	10, 032, 900	12, 600, 611	427, 870	10, 534, 671	58, 928, 660	68, 397, 927
1923..	7, 300, 130	29, 704, 796	10, 674, 470	13, 539, 648	562, 560	12, 863, 974	76, 701, 360	89, 620, 007
1924..	6, 883, 860	28, 772, 161	11, 671, 500	14, 679, 523	516, 000	13, 302, 235	75, 894, 430	89, 868, 956
1925..	8, 074, 200	30, 531, 347	11, 842, 110	14, 770, 042	564, 150	13, 882, 457	85, 649, 440	98, 008, 028
1926..	9, 330, 390	32, 044, 523	12, 977, 740	15, 950, 302	563, 170	14, 167, 480	91, 887, 900	109, 252, 299
1927..	10, 706, 740	35, 287, 206	13, 210, 570	17, 399, 949	600, 060	15, 625, 872	99, 662, 270	112, 439, 824
1928..	9, 556, 500	33, 994, 527	15, 327, 760	19, 693, 945	579, 490	16, 402, 986	96, 864, 650	110, 231, 974

Year	Sandstone		Other stone ¹		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	2, 623, 270	\$5, 283, 842	1, 190, 540	\$1, 920, 903	65, 539, 000	\$96, 709, 143
1920.....	3, 343, 000	7, 310, 290	1, 483, 300	2, 291, 760	78, 527, 000	133, 541, 960
1921.....	2, 640, 460	6, 425, 339	1, 685, 220	2, 163, 801	63, 538, 740	106, 962, 266
1922.....	3, 388, 130	7, 521, 044	1, 520, 880	1, 886, 806	80, 211, 560	122, 066, 928
1923.....	4, 349, 270	9, 174, 706	3, 730, 870	4, 567, 110	103, 318, 660	159, 470, 241
1924.....	3, 894, 690	10, 142, 099	4, 323, 640	5, 105, 139	103, 184, 120	161, 870, 113
1925.....	4, 479, 330	10, 920, 016	5, 242, 140	6, 104, 902	115, 851, 370	174, 216, 792
1926.....	4, 978, 530	11, 149, 029	4, 758, 630	5, 744, 957	124, 496, 360	188, 308, 590
1927.....	5, 050, 600	10, 923, 035	7, 114, 890	6, 971, 336	136, 345, 130	198, 647, 222
1928.....	4, 716, 530	10, 498, 440	6, 824, 580	5, 998, 825	133, 869, 510	196, 820, 697

¹ Includes mica schist, conglomerate, argillite, various light-colored volcanic rocks, serpentine not used as marble, and such other stone as can not be properly classed in any of the main groups.

Stone sold or used by producers in the United States, 1927 and 1928, by uses

Use	1927		1928	
	Quantity	Value	Quantity	Value
Building stone.....cubic feet..	32, 104, 200	\$40, 595, 127	30, 795, 530	\$42, 769, 904
Approximate equivalent in short tons.....	2, 485, 120	-----	2, 453, 330	-----
Monumental stone.....cubic feet..	4, 325, 390	14, 978, 691	4, 203, 780	14, 966, 498
Approximate equivalent in short tons.....	358, 000	-----	347, 760	-----
Paving blocks.....number.....	38, 705, 560	3, 583, 400	35, 426, 860	3, 113, 526
Approximate equivalent in short tons.....	366, 740	-----	349, 290	-----
Curbing.....cubic feet.....	4, 862, 580	4, 939, 716	4, 832, 160	4, 698, 313
Approximate equivalent in short tons.....	378, 230	-----	383, 070	-----
Flagging.....cubic feet.....	737, 680	573, 736	932, 900	717, 049
Approximate equivalent in short tons.....	55, 160	-----	74, 900	-----
Rubble.....short tons.....	809, 020	998, 108	907, 890	1, 249, 703
Riprap.....do.....	4, 618, 500	4, 716, 731	3, 993, 190	3, 865, 895
Crushed stone.....do.....	94, 948, 770	97, 474, 267	91, 265, 360	94, 186, 259
Furnace flux (limestone and marble).....do.....	21, 666, 070	15, 985, 525	23, 123, 870	16, 957, 264
Refractory stone (ganister, mica schist, and dolomite).....short tons.....	1, 362, 920	1, 710, 708	1, 348, 160	1, 745, 066
Agricultural limestone.....do.....	2, 206, 470	3, 360, 704	2, 186, 870	3, 153, 848
Manufacturing industries (limestone and marble).....short tons.....	5, 352, 130	4, 735, 114	5, 639, 750	4, 723, 810
Other.....do.....	1, 738, 000	4, 995, 395	1, 796, 070	4, 673, 562
Total (quantities approximate, in short tons).....	136, 345, 130	198, 647, 222	133, 869, 510	196, 820, 697

Value of stone imported for consumption in the United States, 1919-1928

1919.....	\$787, 961	1924.....	\$2, 437, 654
1920.....	1, 795, 575	1925.....	2, 909, 887
1921.....	1, 253, 959	1926.....	3, 523, 578
1922.....	1, 895, 912	1927.....	4, 536, 407
1923.....	2, 641, 337	1928.....	3, 491, 353

Stone imported for consumption in the United States, 1927 and 1928, by kinds

Kind	1927		1928	
	Quantity	Value	Quantity	Value
Marble, breccia, and onyx:				
In blocks, rough, etc.....cubic feet..	958, 429	\$2, 521, 917	586, 061	\$1, 673, 344
Sawed.....do.....	812	4, 665	8	19
Slabs or paving tiles.....superficial feet..	925, 792	306, 696	845, 464	310, 785
All other manufactures.....	-----	561, 990	-----	483, 071
Mosaic cubes of marble or onyx:				
Loose.....	-----	9, 144	-----	6, 015
Attached to paper.....	-----	74	-----	111
-----	-----	3, 404, 486	-----	2, 473, 345
Granite:				
Dressed.....	-----	319, 644	-----	244, 043
Rough.....cubic feet.....	188, 395	257, 470	178, 427	272, 428
-----	-----	577, 114	-----	516, 471
Stone (other):				
Dressed.....	-----	27, 830	-----	40, 007
Rough (monumental or building stone).....cubic feet..	279, 422	240, 987	244, 346	237, 595
Rough (other).....	-----	285, 990	-----	223, 935
-----	-----	554, 807	-----	501, 537
Grand total.....	-----	4, 536, 407	-----	3, 491, 353

Value of stone exported from the United States, 1919-1928

Year	Marble in blocks, rough or dressed, and other building or monumental stone ¹	Other manufactures of stone ¹	Total	Year	Marble in blocks, rough or dressed, and other building or monumental stone ¹	Other manufactures of stone ¹	Total
1919.....	\$770, 392	\$1, 508, 997	\$2, 279, 389	1924.....	\$499, 602	\$448, 731	\$948, 333
1920.....	774, 442	2, 158, 764	2, 933, 206	1925.....	507, 391	725, 677	1, 233, 068
1921.....	576, 905	1, 697, 570	2, 274, 475	1926.....	687, 115	896, 130	1, 583, 245
1922.....	681, 658	903, 102	1, 584, 760	1927 ²	³ 1, 088, 949	⁴ 1, 005, 636	2, 094, 585
1923.....	625, 442	783, 195	1, 408, 637	1928 ¹	³ 727, 432	⁴ 1, 245, 792	1, 973, 224

¹ Exports classification beginning 1922; prior to 1922 classification read "Stone including marble—unmanufactured and all other."

² Figures not separately recorded for 1927 and 1928 for stone and for cement building blocks and for stone and for cement manufactures.

³ Composed in 1927 of "marble in blocks, rough or dressed" \$237,233, and "other building or monumental stone (including cement building blocks)," \$851,716; in 1928 of \$254,266 and \$473,166, respectively.

⁴ Classification reads "Other manufactures of stone (including other cement manufactures)."

STRONTIUM

No domestic production of strontium ore has been reported since 1918. The canvass has been discontinued.

Strontium chemicals, manufactured in the United States from domestic and imported crude ore, sold in 1919-1924 ¹

Year	Pounds	Value	Year	Pounds	Value
1919.....	2, 191, 409	\$402, 057	1922.....	2, 040, 550	\$204, 022
1920.....	4, 713, 015	864, 251	1923.....	2, 676, 260	303, 719
1921.....	847, 368	118, 655	1924.....	3, 061, 532	303, 456

¹ Canvass discontinued after 1924.

Imports of strontium ore have been as follows: 1928, 759 short tons, valued at \$31,157; 1927, 1,356 tons, \$58,711; 1926, 2,200 tons, \$58,159; 1925, 1,132 tons, \$22,082; 1924, 1,661 tons, \$14,487; 1923, 1,679 tons, \$12,564. No record of similar imports was kept prior to change in tariff (September 22, 1922), but from that date until the end of the year 1,000 pounds, valued at \$40, was imported.

Strontium chemicals and ore imported for consumption in the United States, 1919-1928 ¹

Year	Pounds	Value	Year	Pounds	Value
1919.....	1, 225, 952	\$3, 380	1924.....	3, 993, 226	\$59, 937
1920.....	1, 659, 083	15, 479	1925.....	4, 826, 612	162, 533
1921.....	1, 212, 758	4, 393	1926.....	5, 433, 044	115, 436
1922 ¹	390, 644	22, 986	1927.....	4, 233, 816	149, 383
1923.....	5, 281, 818	131, 420	1928.....	3, 380, 464	136, 561

¹ Celestite (strontium sulphate ore), strontium nitrate, and some other chemicals not included in record prior to Sept. 22, 1922.

No exports of strontium ore or strontium chemicals have been reported.

SULPHUR

Sulphur produced and shipped in the United States, 1919-1928

Year	Produced (long tons)	Shipped		Year	Produced (long tons)	Shipped	
		Long tons	Approximate value			Long tons	Approximate value
1919-----	1, 190, 575	678, 257	\$10, 252, 000	1924-----	1, 220, 561	1, 537, 345	\$25, 000, 000
1920-----	1, 255, 249	1, 517, 625	30, 000, 000	1925-----	1, 409, 262	1, 858, 003	29, 000, 000
1921-----	1, 879, 150	954, 344	17, 000, 000	1926-----	1, 890, 027	2, 072, 657	37, 300, 000
1922-----	1, 830, 942	1, 343, 624	22, 000, 000	1927-----	2, 111, 618	2, 072, 109	38, 300, 000
1923-----	2, 036, 097	1, 618, 841	26, 000, 000	1928-----	1, 981, 873	2, 082, 924	37, 500, 000

Sulphur imported into and exported from the United States, 1919-1928

Year	Imports for consumption		Exports	
	Long tons	Value	Long tons	Value
1919-----	101	\$8, 633	224, 712	\$6, 325, 552
1920-----	136	26, 828	477, 450	8, 994, 350
1921-----	50	5, 878	285, 762	4, 524, 768
1922-----	296	14, 743	487, 969	7, 209, 357
1923-----	465	21, 535	474, 475	7, 216, 107
1924-----	1, 005	40, 293	484, 143	7, 894, 201
1925-----	100	4, 411	632, 250	11, 153, 781
1926-----	48	1, 052	582, 324	11, 154, 640
1927-----	3, 384	34, 487	803, 300	16, 798, 600
1928-----	4, 787	21, 320	704, 933	15, 051, 841

TALC AND SOAPSTONE

Talc and soapstone¹ sold by producers in the United States, 1919-1928, by classes

Year	Crude		Sawed and manufactured				Ground		Total	
			Talc		Soapstone					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	15, 625	\$73, 437	921	\$147, 339	16, 504	\$530, 163	151, 793	\$1, 601, 736	184, 843	\$2, 352, 675
1920	11, 008	43, 820	1, 415	139, 335	19, 707	709, 400	178, 505	2, 142, 894	210, 635	3, 035, 449
1921	2, 150	12, 911	(²)	(²)	¹ 17, 423	² 627, 826	102, 413	1, 115, 205	121, 986	1, 755, 942
1922	4, 981	22, 582	654	86, 333	22, 700	712, 144	170, 349	2, 038, 838	198, 684	2, 859, 897
1923	5, 706	50, 125	682	114, 772	22, 857	932, 098	167, 447	1, 915, 258	196, 692	3, 012, 253
1924	5, 710	22, 247	846	109, 405	25, 630	1, 288, 885	171, 635	2, 095, 019	203, 821	3, 515, 556
1925 ¹	5, 684	24, 533	895	107, 691	(³)	(²)	175, 677	1, 879, 569	182, 256	2, 011, 793
1926 ¹	5, 988	26, 723	1, 528	130, 253	(²)	(²)	174, 052	1, 954, 018	181, 568	2, 110, 994
1927 ¹	5, 706	25, 365	1, 494	111, 650	(²)	(²)	185, 116	2, 097, 709	192, 316	2, 234, 724
1928 ¹	6, 360	48, 031	936	70, 394	(²)	(²)	195, 680	2, 419, 569	202, 976	2, 537, 994

¹ Beginning 1925, figures represent talc only; Bureau of Mines not at liberty to publish figures for soapstone.

² Talc included under "Soapstone."

Bureau of Mines not at liberty to publish figures.

Talc imported for consumption in the United States, 1919-1928

Year	Crude and unground steatite and French chalk		Manufactures (except toilet preparations) wholly or partly finished ¹		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	1,641	\$10,105	12,961	\$248,899	14,602	\$259,004
1920.....	941	7,206	21,739	443,514	22,680	450,720
1921.....	153	2,279	11,468	239,469	11,621	241,748
1922.....	248	9,850	18,196	367,528	18,444	377,378
1923.....	560	20,653	19,405	402,238	19,965	422,891
1924.....	313	4,847	17,496	337,508	17,809	342,355
1925.....	121	6,547	20,872	443,985	20,993	450,532
1926.....	199	16,366	23,642	523,716	23,841	540,082
1927.....	377	27,326	24,817	523,056	25,194	550,382
1928.....	459	33,276	26,590	546,639	27,049	579,915

¹ Prior to change in tariff, Sept. 22, 1922, the classification was "Talc, steatite, and French chalk—cut, ground, or washed."

No material that might be classed as soapstone is imported.

Exports of "talcum and other toilet powders" have been as follows: 1928, 1,568 short tons, valued at \$1,605,630; 1927, 1,627 tons, \$1,621,068; 1926, 1,645 tons, \$1,726,933; 1925, 1,734 tons, \$1,882,196; 1924, 1,614 tons, \$1,688,211; 1923, 1,907 tons, \$1,671,588; 1922, 1,821 tons, \$1,397,542. Exports were not separately classified prior to 1922.

TANTALUM*Columbite, mined in the United States, shipped in 1919-1928*

Year	Pounds	Value	Year	Pounds	Value
1919.....	300	\$90	1924.....	1,197	\$598
1920.....	4,000	1,450	1925.....		
1921.....	3,400	1,150	1926.....	2,100	650
1922.....	600	240	1927.....	1,100	378
1923.....	1,350	540	1928.....	34,899	26,332

No imports of tantalum or tantalum ores were recorded for 1919, 1922, 1924, or 1928. For other years in the decade 1919 to 1928 imports have been recorded as follows: 1920, 60 pounds of "ferro-alloys (tantalum)," valued at \$54; 1921, 1,229 pounds of "ferro-alloys (tantalum)," \$788, and 6,785 pounds of "steel-hardening ores (tantalum)," \$1,327. Beginning with 1923 the classification is "Ores of ferro-alloying metals (tantalum)" and the figures are as follows: 1923, 5,600 pounds, \$3,031; 1925, 5,022 pounds, \$1,347; 1926, 350 pounds, \$149; 1927, 15,119 pounds, \$20,012.

No separate record of exports is kept.

TELLURIUM

Tellurium is a by-product of the electrolytic refining of copper. The production of tellurium in 1928 was 2,590 pounds, compared with an output of 1,659 pounds in 1927 and 917 pounds in 1926. The sales in 1928 amounted to 932 pounds, valued at \$1,731, compared with sales of 1,003 pounds, valued at \$1,913, in 1927, and 1,106 pounds,

valued at \$2,229, in 1926. Figures for years prior to 1926 are not available for publication.

Imports and exports of tellurium are not reported.

THORIUM MINERALS

In 1925, 2,000 pounds of monazite, estimated to contain 6 per cent of thorium, was shipped from Florida. The value of this monazite is estimated by the Bureau of Mines as \$120. No monazite is known to have been produced in the United States from 1919 to 1924 or from 1926 to 1928.

Monazite sand and thorium nitrate imported for consumption in the United States, 1919-1928

Year	Monazite sand		Thorium nitrate	
	Pounds	Value	Pounds	Value
1919.....	632, 568	\$48, 768	3, 307	\$5, 250
1920.....	1, 814, 183	141, 528	35, 640	43, 221
1921.....	50	40	44, 554	89, 672
1922.....	3, 466, 844	210, 187	43, 254	42, 096
1923.....	253, 730	11, 334	24, 027	29, 789
1924.....	546, 560	18, 320	14, 150	13, 721
1925.....			21, 519	22, 661
1926.....	669, 760	23, 816	21, 403	27, 955
1927.....	1, 193, 920	41, 029	10, 492	13, 514
1928.....	884, 800	24, 151	12, 431	14, 149

Exports of thorium nitrate in 1922 amounted to 1,103 pounds, valued at \$3,149. Data for other years are not separately shown.

TIN

Tin mined in the United States (including Alaska), 1919-1928

[Metallic tin obtainable from concentrates produced in tin mining]

Year	Short tons	Value ¹	Year	Short tons	Value ¹
1919.....	56	\$73, 400	1924.....	7	\$7, 028
1920.....	22	22, 000	1925.....	14	15, 980
1921.....	4	2, 400	1926.....	8	10, 400
1922.....	² 1	912	1927.....	27	34, 600
1923.....	2	1, 623	1928.....	47	47, 400

¹ Value calculated at average price per pound of Straits tin in New York, as published by American Metal Market.

² 2,800 pounds.

Smelter production of metallic tin in the United States, 1919-1928, in short tons

1919.....	12, 236	1923.....	7, 466
1920.....	17, 652	1924.....	486
1921.....	11, 542	1925-1928.....	(¹)
1922.....	9, 108		

¹ None reported.

Secondary tin recovered as metal and in alloys and chemical compounds in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	24, 033	\$29, 868, 200	1924.....	31, 300	\$31, 062, 100
1920.....	23, 500	22, 705, 700	1925.....	30, 950	35, 165, 400
1921.....	16, 900	9, 668, 500	1926.....	33, 400	42, 511, 500
1922.....	19, 510	12, 443, 500	1927.....	36, 900	46, 302, 100
1923.....	30, 210	25, 316, 000	1928.....	35, 800	35, 678, 300

Metallic tin imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	44, 849	\$50, 890, 019	1924.....	72, 866	\$68, 953, 193
1920.....	62, 795	73, 440, 872	1925.....	85, 843	95, 121, 111
1921.....	27, 101	16, 645, 719	1926.....	86, 418	104, 793, 396
1922.....	67, 416	40, 797, 986	1927.....	79, 679	100, 865, 205
1923.....	77, 206	61, 092, 354	1928.....	87, 327	86, 983, 174

Tin ore (concentrate) imported into the United States, 1919-1928

[General imports]

Year	Short tons	Value	Year	Short tons	Value
1919.....	19, 196	\$11, 871, 948	1924.....	¹ 174	\$71, 094
1920.....	34, 148	18, 795, 162	1925.....	¹ 214	98, 489
1921.....	15, 340	5, 672, 861	1926.....	¹ 339	187, 396
1922.....	13, 804	5, 504, 434	1927.....	¹ 137	79, 089
1923.....	3, 015	2, 169, 055	1928.....	¹ 146	69, 227

¹ Recorded as tin content.

Exports of tin ore are insignificant.

Metallic tin (pigs, bars, etc.) of domestic manufacture exported from the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	306	\$415, 921	1924.....	469	\$453, 482
1920.....	706	770, 375	1925.....	404	445, 782
1921.....	1, 154	748, 077	1926.....	756	708, 151
1922.....	901	574, 792	1927.....	1, 131	888, 563
1923.....	840	646, 250	1928.....	391	325, 668

TITANIUM MINERALS

Titanium minerals produced in the United States, 1919-1928

Year	Rutile concentrates			Ilmenite concentrates		
	Short tons	Percentage of TiO ₂	Value	Short tons	Percentage of TiO ₂	Value
1919 ¹	102	94-96	\$20,400	106	48-50	\$2,120
1920.....	277	94-96	(²)	268	50	(²)
1921.....						
1922.....	310	95	(²)	5,181	52-54	(²)
1923.....	270	95	(²)	6,270	52	(²)
1924.....				4,769	52	³ 76,300
1925.....	46	95	³ 11,000	5,566	52	³ 89,000
1926 ⁴	30	95	³ 7,500	4,813	52	³ 77,000
1927.....			(²)	3,500	50	44,000
1928.....	(²)	(²)	(²)	(²)	(²)	(²)

¹ Virginia production only; information regarding Florida not available for publication.² Bureau of Mines not at liberty to publish figures.³ Estimate by Bureau of Mines.⁴ Figures for Florida only. Bureau of Mines not at liberty to publish figures for Virginia.

No imports of titanium or "titanium steel-hardening" ores have been recorded since 1918, although ilmenite is known to have been imported from Senegal, West Africa; from Brazil; from Travancore, India; and possibly from other places. Such imports were not separately classified by the Bureau of Foreign and Domestic Commerce until 1928, when 17,224 short tons of ilmenite, valued at \$79,640, was imported. Imports of "titanium potassium oxalate and all compounds and mixtures containing titanium" amounted to 123,162 pounds, valued at \$20,136, in 1928; to 107,389 pounds, \$16,145, in 1927; to 81,604 pounds, \$12,232, in 1926; to 81,721 pounds, \$12,368, in 1925; to 24,134 pounds, \$3,639, in 1924; to 39,763 pounds, \$6,423, in 1923; and to 82,544 pounds, \$20,596, from September 22 to December 31, 1922. Similar imports were not separately classified prior to change in tariff. For imports of ferrotitanium see under Ferro-alloys.

No separate record of exports of titanium, "titanium steel-hardening" ores, or ferrotitanium is kept.

TRIPOLI

[See Abrasive materials]

TUNGSTEN

Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide), produced in the United States, sold in 1919-1928, and average value per unit

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per unit			Total	Average per unit
1919.....	327	\$353,900	\$18.02	1924.....	565	\$287,000	\$8.47
1920.....	216	101,800	7.86	1925.....	1,191	755,500	10.57
1921.....				1926.....	1,382	920,400	11.10
1922.....				1927.....	1,164	724,000	10.37
1923.....	241	144,600	10.00	1928.....	1,208	753,900	10.40

Tungsten-bearing ore¹ imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919-----	9,408	\$6,261,190	1924-----		
1920-----	1,949	779,593	1925-----	427	\$206,326
1921-----	1,614	276,757	1926-----	1,267	566,996
1922-----	1,651	279,190	1927-----	1,085	540,409
1923-----			1928-----	1,428	672,199

¹ Prior to Sept. 22, 1922, imports recorded as ore; beginning with change in tariff, recorded as tungsten content of ore.

For imports of tungsten and ferrotungsten see under Ferro-alloys.

For 1922 the following domestic exports are recorded: "Tungsten ores and concentrates (tungsten content)," 717 pounds, valued at \$594. No tungsten ores of domestic production are recorded as exported in 1919 to 1921, and, although exports for later years are not separately shown, it is practically certain that no domestic ores have been exported.

For exports of tungsten and ferrotungsten see under Ferro-alloys.

URANIUM AND VANADIUM ORES*Uranium and vanadium ores shipped from mines in the United States, 1919-1928*

Year	Ores		Radium isolated (grams)	Estimated content of ores		
	Short tons	Approximate value as ore		Radium (grams)	Uranium (short tons)	Vanadium (short tons)
1919-----	14,509	\$1,630,900	28,648	29.0	95.7	284.2
1920-----	35,076	2,401,000	32,539	43.4	143.5	526.7
1921-----	8,540	876,000	35,693	33.0	109.0	201.5
1922-----	929	166,016	24,189	7.0	23.2	25.9
1923-----	2,025	150,000	12,212	5.5	18.2	63.3
1924-----	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
1925-----	13,070	331,000	(¹)	4.3	14.3	216
1926-----	21,624	329,000	(¹)	.4	1.2	330.7
1927-28-----	(¹)	(¹)	-----	(¹)	(¹)	(¹)

¹ Bureau of Mines not at liberty to publish figures.

Value of uranium salts and oxide, including radium salts, imported for consumption in the United States, 1919-1928

1919-----	\$12,960	1924-----	\$418,307
1920-----	3	1925-----	480,889
1921-----	8,552	1926-----	596,433
1922-----	28,685	1927-----	452,633
1923-----	500,456	1928-----	715,447

No imports of "uranium-radium ore (steel-hardening)" were recorded for 1922 to 1928 and for 1919. Imports in 1920 and 1921 were 396 pounds, \$1,110, and 250 pounds, \$446, respectively.

Vanadium ore (steel-hardening) imported for consumption in the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919-----	3,013	\$67,846	1924-----	7,058	\$722,731
1920-----	10,337	1,080,935	1925-----	2,368	339,468
1921-----	5,154	543,061	1926-----	8,368	914,114
1922-----	306	86,776	1927-----	6,943	561,051
1923-----	2,089	229,210	1928-----	552	49,771

For imports of ferrovanadium see under Ferro-alloys.

No separate record is kept of vanadium exports. For exports of ferrovanadium see under Ferro-alloys.

ZINC ¹

Primary zinc produced in the United States from domestic ores, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	452,272	\$66,032,000	1924.....	515,831	\$67,058,000
1920.....	450,045	72,907,000	1925.....	555,631	84,456,000
1921.....	198,232	19,823,000	1926.....	611,991	91,799,000
1922.....	353,274	40,273,000	1927.....	576,960	73,851,000
1923.....	508,335	69,134,000	1928.....	591,525	72,166,000

¹ For prices of zinc, see statement on p. A8.

Primary zinc produced in the United States, 1924-1928, by sources of ore, in short tons

Source	1924	1925	1926	1927	1928
United States.....	515,831	555,631	611,991	576,960	591,525
Foreign:					
Canada.....	1,396	7,997			
Mexico.....	112	9,318	6,431	15,556	11,056
Total foreign.....	1,508	17,315	6,431	15,556	11,056
Grand total.....	517,339	572,946	618,422	592,516	602,581

Primary zinc produced in the United States, 1924-1928, by method of reduction and by location of reduction plant, in short tons

	1924	1925	1926	1927	1928
Distilled:					
Arkansas.....	28,447	27,145	32,712	26,317	20,505
Illinois.....	93,370	109,672	110,381	102,768	103,765
Kansas.....	28,640	25,765	33,671	33,144	33,923
Oklahoma.....	118,487	138,906	136,560	120,801	106,557
Pennsylvania.....	83,016	99,899	100,538	106,099	108,802
Other States.....	87,886	92,555	92,964	90,758	68,869
Electrolytic:					
Idaho.....					1,939
Montana.....	77,493	79,004	111,596	112,629	158,221
	517,339	572,946	618,422	592,516	602,581

Secondary zinc recovered as metal in the United States, 1919-1928, in short tons

Year	Redistilled	Remelted	Recovered in alloys, excluding old brass remelted	Recovered in remelted brass (estimate)
1919.....	19,748	20,162	6,062	62,400
1920.....	21,371	21,479	7,650	65,000
1921.....	17,573	16,260	5,840	38,600
1922.....	32,988	36,326	10,250	60,000
1923.....	39,434	25,776	8,630	65,000
1924.....	35,486	23,400	10,500	63,000
1925.....	39,181	22,249	13,300	53,300
1926.....	40,799	23,771	13,430	63,000
1927.....	42,784	22,016	12,400	63,200
1928.....	48,666	22,034	12,500	66,000

Zinc imported for consumption in the United States, 1919-1928

Year	Blocks or pigs		Sheets		Old		Zinc dust		Manu- fac- tures	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1919.....	32	\$2, 284	1	\$249	37	\$2, 216	52	\$5, 753	\$1, 258	\$11, 760
1920.....	(1)	17	4	614	14	1, 065	17	6, 207	1, 746	9, 649
1921.....	6, 598	559, 870	6, 688	496, 445	6	341	42	1, 121	8, 290	1, 066, 067
1922.....	40	3, 327	416	59, 037	46	2, 403	79	5, 614	9, 517	79, 898
1923.....	1	375	(1)	41	20	1, 624	4	891	16, 331	19, 262
1924.....	11	1, 973	(1)	88	14	1, 493	59	9, 241	20, 089	32, 884
1925.....	(1)	303	(1)	55	24	2, 495	116	20, 936	18, 979	42, 768
1926.....	(1)	195	(1)	46	21	1, 315	2	451	44, 574	46, 581
1927.....	39	5, 089	1	271	19	1, 443	(1)	114	91, 519	98, 436
1928.....	(1)	66	3	2, 556	3	260	146	14, 147	115, 784	132, 813

¹ Less than 1 ton.*Zinc content of zinc ores ¹ imported for consumption in the United States, 1919-1928*

Year	Short tons	Value	Year	Short tons	Value
1919.....	2, 978	\$119, 540	1924.....	² 332	\$32, 850
1920.....	6, 971	198, 156	1925.....	² 57	6, 205
1921.....	9, 387	252, 951	1926.....	² 55	4, 181
1922.....	² 1, 895	18, 903	1927.....	² 154	10, 401
1923.....	² 2, 007	273, 105	1928.....	² 344	19, 121

¹ Classification as follows: 1919-1922, "Ore, zinc-bearing, including calamine (zinc content)"; 1923-1928, "Zinc ores (zinc content)."² Content of ore imported duty free and containing less than 10 per cent of zinc is separately recorded after Sept. 21, 1922, but is excluded from figures as zinc content is not recovered.*Zinc exported from the United States, 1919-1928*

Year	Domestic				Foreign slabs	
	Slabs		Sheets			
	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	109, 746	\$17, 524, 153	19, 762	\$5, 212, 002	12, 256	\$1, 943, 507
1920.....	74, 046	12, 495, 144	11, 852	2, 832, 993	28, 132	4, 331, 636
1921.....	1, 753	204, 984	1, 816	425, 618	1, 256	100, 677
1922.....	26, 815	2, 994, 625	3, 217	574, 491	3, 471	429, 122
1923.....	42, 131	5, 961, 625	3, 732	764, 369	7, 080	941, 257
1924.....	¹ 72, 583	¹ 9, 538, 459	3, 658	784, 728	(1)	(1)
1925.....	¹ 76, 351	¹ 11, 654, 441	4, 196	926, 841	(1)	(1)
1926.....	¹ 42, 920	¹ 6, 360, 671	4, 641	1, 086, 967	(1)	(1)
1927.....	¹ 45, 695	¹ 6, 035, 382	3, 922	869, 425	(1)	(1)
1928.....	¹ 25, 289	¹ 3, 013, 679	4, 325	906, 515	(1)	(1)

¹ Foreign included with domestic. Not separately recorded after 1923.

ZINC RESIDUUM

[See Manganiferous zinc residuum]

ZIRCONIUM MINERALS

The Bureau of Mines is not at liberty to publish figures covering shipments of zircon in 1928. The bureau is advised that shipments of zircon from Pablo Beach, Fla., from 1922 to 1927 were as shown in the table that follows; no shipments were reported for 1919 to 1921.

*Zircon, produced in the United States, shipped in 1922-1928*¹

Year	Short tons	Value (estimate by Bureau of Mines)	Year	Short tons	Value (estimate by Bureau of Mines)
1922.....	10	\$1,000	1926.....	1,292	\$129,200
1923.....	153	15,300	1927.....	3,646	364,600
1924.....	281	28,100	1928.....	(²)	(²)
1925.....	624	62,400			

¹ No shipments reported for 1919 to 1921.² Bureau of Mines not at liberty to publish figures.*Zirconium ores (steel-hardening) imported for consumption in the United States, 1919-1928*

Year	Pounds	Value	Year	Pounds	Value
1919.....	11,023	\$332	1924.....	616,220	\$4,878
1920.....			1925.....		
1921.....	131,016	3,003	1926.....		
1922.....	67,037	4,072	1927.....	4,488	182
1923.....			1928.....	863,685	9,788

STATE TABLES

Mineral production of Alabama in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Asbestos.....short tons			(1)	(1)
Asphalt (native).....do	32, 650	\$128, 700	(1)	(1)
Bauxite.....long tons	4, 060	24, 690	(1)	(1)
Cement.....barrels	² 7, 313, 494	² 10, 615, 428	² 6, 696, 684	² \$8, 233, 872
Clay products.....		² 4, 823, 670		² 4, 072, 802
Clay, raw.....short tons	127, 397	³ 176, 418	131, 808	³ 178, 934
Coal.....do	19, 765, 866	44, 524, 000	17, 621, 362	39, 601, 000
Coke.....do	4, 364, 354	³ 13, 500, 234	4, 327, 324	³ 13, 260, 178
Ferro-alloys.....long tons	(1 ⁵)	(1 ⁵)	(1 ⁵)	(1 ⁵)
Graphite, crystalline.....pounds	3, 474, 000	146, 730	1, 575, 500	81, 785
Iron ore:				
Sold to furnaces.....long tons	6, 508, 419	12, 973, 597	6, 159, 863	11, 599, 176
Sold for paint.....do			80	(1)
Iron, pig.....do	2, 705, 240	³ 50, 193, 057	2, 525, 812	³ 42, 194, 935
Lime.....short tons	206, 010	1, 566, 287	192, 364	1, 407, 232
Manganese ore.....long tons	(1)	(1)	(1)	(1)
Manganiferous ore.....do	(1)	(1)		
Mica, sheet.....pounds	(1)	(1)	(1)	(1)
Mineral waters.....gallons sold	(6)	(6)	(6)	(6)
Sand and gravel.....short tons	2, 085, 696	1, 292, 233	3, 315, 985	1, 719, 222
Sand-lime brick.....thousands	(1 ³)	(1 ³)		
Stone.....short tons	1, 238, 750	1, 797, 375	1, 261, 190	2, 197, 831
Miscellaneous ⁷		2, 975, 147		3, 490, 308
Total value, eliminating duplications.....		78, 640, 669		69, 807, 334

¹ Value included under "Miscellaneous."² Exclusive of puzzolan, value for which is included under "Miscellaneous."³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ Value not included in total value for State.⁶ No canvass.⁷ Includes minerals indicated by "1," "2," and "4" above.*Mineral production of Alaska in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Antimony ore.....short tons			(1)	(1)
Coal.....do	104, 300	\$548, 000	126, 100	\$662, 000
Copper.....pounds	55, 343, 000	7, 249, 933	41, 421, 000	5, 964, 624
Gold.....troy ounces	286, 719	5, 927, 000	331, 127	6, 845, 000
Lead.....short tons	1, 008	127, 008	1, 019	118, 204
Mercury.....flasks	(1)	(1)		
Natural gas.....M cubic feet	(1)	(1)	(1)	(1)
Natural gasoline.....gallons	19, 000	2, 000	26, 000	3, 000
Ores (crude), etc.:				
Copper.....short tons	645, 000	(2)	579, 500	(2)
Dry and siliceous (gold and silver).....do	4, 352, 000	(2)	3, 736, 500	(2)
Petroleum.....barrels	(1)	(1)	(1)	(1)
Platinum and allied metals.....troy ounces	115	6, 940	16	2, 061
Silver.....do	627, 800	355, 962	454, 700	266, 000
Stone.....short tons	(1)	(1)	(1)	(1)
Tin (metallic equivalent).....do	27	34, 400	41	41, 400
Miscellaneous ³		151, 197		122, 200
Total value, eliminating duplications.....		14, 402, 440		14, 024, 459

¹ Value included under "Miscellaneous."² Not valued as ore; value of recoverable metal content included under the metals.³ Includes minerals indicated by "1" above.

Mineral production of Arizona in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Asbestos.....short tons.....	(1)	(1)	(1)	(1)
Clay products.....		\$345, 391		\$297, 159
Clay, raw.....short tons.....	(1 ³)	(1 ³)	11, 473	\$45, 892
Coal.....do.....	4, 583	6, 000	3, 600	16, 000
Copper.....pounds.....	682, 190, 547	89, 366, 962	732, 276, 803	105, 447, 860
Feldspar (crude).....long tons.....	(1)	(1)	(1)	(1)
Fuller's earth.....short tons.....	(1)	(1)	(1)	(1)
Gems and precious stones.....	(4)	(4)	(4)	(4)
Gold.....troy ounces.....	200, 495	4, 144, 591	191, 927	3, 967, 488
Gypsum.....short tons.....	(1)	(1)	(1)	(1)
Lead.....do.....	9, 933	1, 251, 556	7, 190	834, 096
Lime.....do.....	41, 859	390, 074	36, 244	343, 167
Manganese ore.....long tons.....	3, 905	41, 880	3, 507	35, 500
Manganiferous ore.....do.....	179	754	214	(1)
Mercury.....flasks.....	(1)	(1)	(1)	(1)
Molybdenum.....pounds.....	(1)	(1)	(1)	(1)
Ores (crude), etc.:.....				
Copper.....short tons.....	21, 677, 976	(5)	22, 584, 270	(5)
Copper-lead and copper-lead-zinc.....do.....	11, 930	(5)	22, 083	(5)
Dry and siliceous (gold and silver).....do.....	151, 701	(5)	146, 825	(5)
Lead.....do.....	137, 195	(5)	50, 651	(5)
Lead-zinc.....do.....	11, 752	(5)	24, 937	(5)
Zinc.....do.....	1, 320	(5)		
Pumice.....do.....	20	200	40	300
Salt.....do.....	(1)	(1)	40	400
Sand and gravel.....do.....	92, 956	46, 363	566, 777	282, 996
Silver.....troy ounces.....	6, 847, 680	3, 882, 635	6, 791, 351	3, 972, 940
Sodium sulphate from natural sources.....short tons.....	(1)	(1)	(1)	(1)
Stone.....do.....	311, 930	297, 206	408, 210	221, 154
Sulphuric acid (60° Baumé) ⁶ do.....	72, 153	(1 ³)	66, 415	(1 ³)
Tungsten ore (60 per cent concentrates).....do.....	(1)	(1)		
Zinc.....do.....	1, 134	145, 213	639	77, 997
Miscellaneous ⁷ do.....		1, 113, 086		917, 680
Total value, eliminating duplications.....		100, 558, 556		115, 999, 643

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ From copper smelting.⁷ Includes minerals indicated by "1" above.*Mineral production of Arkansas in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Bauxite.....long tons.....	303, 830	\$1, 892, 860	361, 236	\$2, 193, 230
Clay products.....		^{1 2} 1, 285, 720		^{1 2} 1, 580, 571
Clay, raw.....short tons.....	335	³ 1, 966	266	³ 1, 064
Coal.....do.....	1, 548, 834	5, 393, 000	1, 660, 973	5, 615, 000
Gems and precious stones.....		(5)		(5)
Iron ore sold for magnets.....long tons.....	5	(5)	20	(5)
Lead.....short tons.....	23	2, 898	38	4, 408
Lime.....do.....	35, 375	307, 335	40, 438	339, 624
Manganese ore.....long tons.....	2, 605	64, 202	3, 623	81, 862
Manganiferous ore.....do.....	7, 444	48, 678	7, 136	43, 880
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Natural gas.....M cubic feet.....	30, 450, 000	4, 281, 000	20, 235, 000	3, 562, 000
Natural gasoline.....gallons.....	37, 498, 000	2, 281, 000	32, 677, 000	2, 568, 000
Oilstones.....short tons.....	(5)	(5)	194	113, 140
Ores (lead and zinc).....do.....	(5)	(5)	(5)	(5)
Petroleum.....barrels.....	40, 005, 000	42, 400, 000	32, 096, 000	27, 450, 000
Sand and gravel.....short tons.....	1, 461, 693	832, 520	1, 683, 384	991, 408
State.....				(5)
Stone.....short tons.....	418, 770	486, 792	381, 690	441, 596
Zinc.....do.....	128	16, 384	86	10, 492
Miscellaneous ⁷ do.....		156, 711		14, 569
Total value, eliminating duplications.....		59, 449, 100		45, 009, 780

¹ Figures obtained through cooperation with Bureau of the Census.² Exclusive of pottery, value for which is included under "Miscellaneous."³ Value not included in total value for State.⁴ No canvass.⁵ Value included under "Miscellaneous."⁶ Figures not available.⁷ Includes minerals indicated by "3" and "4" above.

Mineral production of California in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Antimony ore.....short tons..			25	\$962
Asphalt (native).....do.....	(1)	(1)	(1)	(1)
Barite.....do.....	13, 919	\$71, 708	12, 557	51, 502
Borates.....do.....	(1)	(1)	(1)	(1)
Briquets, fuel.....do.....	(1 2)	(1 2)	(1 2)	(1 2)
Bromine.....pounds.....	(1)	(1)	(1)	(1)
Calcium chloride.....short tons..	(1)	(1)	(1)	(1)
Cement.....barrels.....	14, 433, 153	26, 623, 396	13, 699, 851	25, 906, 942
Chromite.....long tons.....	201	5, 063	652	14, 642
Clay products.....		³ 20, 994, 490		³ 20, 993, 347
Clay, raw.....short tons.....	290, 309	² 778, 420	339, 497	² 963, 843
Coal.....do.....	(1)	(1)	(1)	(1)
Copper.....pounds.....	27, 133, 008	3, 554, 424	25, 150, 743	3, 621, 707
Diatomite.....short tons.....	(1)	(1)	(1)	(1)
Feldspar (crude).....long tons..	5, 260	43, 329	11, 891	81, 199
Gems and precious stones.....		(1)		(1)
Gold.....troy ounces.....	564, 586	11, 671, 018	521, 740	10, 785, 315
Graphite, crystalline.....pounds..	(1)	(1)		
Gypsum.....short tons.....	(1)	(1)	(1)	(1)
Ilmenite.....do.....	(1)	(1)		
Lead.....do.....	1, 359	171, 235	946	109, 680
Lime.....do.....	64, 934	708, 010	60, 751	617, 472
Lithium minerals.....do.....	(1)	(1)		
Magnesite.....do.....	43, 750	507, 500	41, 300	454, 300
Magnesium salts (natural).....pounds..	(1)	(1)	(1)	(1)
Marl, calcareous.....short tons..	(1)	(1)	(1)	(1)
Mercury.....flasks.....	5, 748	670, 217	7, 070	861, 692
Mineral waters.....gallons sold..	(1)	(1)	(1)	(1)
Natural gas.....M cubic feet.....	212, 364, 000	50, 946, 000	246, 215, 000	56, 695, 000
Natural gasoline.....gallons.....	498, 020, 000	52, 436, 000	584, 111, 000	53, 885, 000
Ores (crude), etc.:.....				
Copper.....short tons.....	854, 084	(1)	901, 562	(1)
Copper-lead.....do.....	193	(1)	137	(1)
Dry and siliceous (gold and silver).....do.....	619, 122	(1)	797, 441	(1)
Lead.....do.....	14, 066	(1)	3, 401	(1)
Lead-zinc.....do.....	14, 679	(1)		
Zinc.....do.....	24, 266	(1)		
Peat.....do.....	(1)	(1)	(1)	(1)
Pebbles for grinding.....do.....	288	1, 856	372	2, 408
Petroleum.....barrels.....	231, 196, 000	260, 735, 000	231, 811, 000	230, 000, 000
Platinum and allied metals.....troy ounces..	132	12, 646	259	32, 984
Potassium salts.....short tons.....	(1)	(1)	(1)	(1)
Pumice.....do.....	2, 434	22, 286	4, 263	35, 217
Pyrites.....long tons.....	(1)	(1)	(1)	(1)
Salt.....short tons.....	300, 880	1, 827, 750	383, 730	2, 292, 296
Sand and gravel.....do.....	14, 260, 128	8, 045, 257	15, 909, 132	8, 698, 884
Sand and sandstone (finely ground).....do.....			(1)	(1)
Sand-lime brick.....thousands.....	(1 2)	(1 2)	(1 2)	(1 2)
Shale oil.....gallons.....	(1)	(1)		
Silica (quartz).....short tons.....	6, 755	61, 802	5, 719	47, 789
Silver.....troy ounces.....	1, 620, 242	918, 677	1, 478, 771	865, 081
Slate.....do.....		(1)		(1)
Sodium salts (carbonate, bicarbonate, and trona) from natural sources.....short tons..	67, 240	1, 253, 352	79, 830	1, 578, 256
Stone.....do.....	9, 764, 740	9, 963, 054	7, 838, 420	7, 516, 482
Talc.....do.....	15, 760	238, 755	17, 830	271, 413
Tin (metallic equivalent).....do.....			4	4, 000
Tungsten ore (60 per cent concentrates).....do.....	(1)	(1)	(1)	(1)
Zinc.....do.....	4, 031	516, 008		
Miscellaneous ¹ do.....		7, 588, 545		8, 840, 350
Total value, eliminating duplications.....		459, 497, 072		434, 261, 175

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Bureau of Mines not at liberty to publish figures.⁷ No data available.⁸ Includes minerals indicated by "1" above.

Mineral production of Colorado in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Arsenious oxide.....short tons			115	\$9,501
Barite.....do			40	340
Cement.....barrels	(1)	(1)	(1)	(1)
Clay products.....		² \$2,998,486		² 2,998,242
Clay, raw.....short tons	218,255	⁴ 319,994	155,075	⁴ 256,548
Coal.....do	9,724,075	27,044,000	9,847,707	27,613,000
Coke.....do	788,586	(1 ⁴)	750,022	(1 ⁴)
Copper.....pounds	5,670,581	742,846	8,594,646	1,237,629
Feldspar (crude).....long tons	(1)	(1)	(1 ⁴)	(1 ⁴)
Ferro-alloys.....do			(1 ⁴)	(1 ⁴)
Fluorspar.....short tons	6,432	(1)	1,815	18,040
Fuller's earth.....do			(1)	(1)
Gems and precious stones.....		(⁵)		(⁵)
Gold.....troy ounces	255,377	5,279,118	256,623	5,304,876
Gypsum.....short tons	(1)	(1)	(1)	(1)
Iron ore.....long tons	32,206	(1)	52,713	(1)
Iron, pig.....do	(1 ⁴)	(1 ⁴)	(1 ⁴)	(1 ⁴)
Lead.....short tons	33,386	4,206,671	26,751	3,103,100
Lime.....do	11,900	125,875	8,114	88,775
Manganese ore.....long tons	(1)	(1)		
Manganiferous ore:				
For fluxing.....do	1,029	(1)	48	(1)
For other purposes.....do	26,828	126,938	18,599	99,823
Mica:				
Scrap.....short tons	(1)	(1)	(1)	(1)
Sheet.....pounds			(1)	(1)
Micaceous minerals (vermiculite).....short tons	(1)	(1)	1	64
Mineral paints, zinc and lead pigments.....do	(1 ⁴)	(1 ⁴)	(1 ⁴)	(1 ⁴)
Mineral waters.....gallons sold	(⁵)	(⁵)	(⁵)	(⁵)
Molybdenum.....pounds	(1)	(1)	(1)	(1)
Natural gas.....M cubic feet	1,725,400	290,000	2,931,000	786,000
Natural gasoline.....gallons	912,000	64,000	1,909,000	136,000
Ores (crude), etc.:				
Copper.....short tons	467	(⁶)	11,983	(⁶)
Copper-lead.....do	410	(⁶)	366	(⁶)
Dry and siliceous (gold and silver).....do	1,035,305	(⁶)	894,455	(⁶)
Lead.....do	61,275	(⁶)	26,687	(⁶)
Lead-zinc.....do	508,679	(⁶)	492,593	(⁶)
Zinc.....do	392	(⁶)		
Petroleum.....barrels	2,831,000	3,400,000	2,774,000	2,750,000
Sand and gravel.....short tons	622,204	465,818	806,051	605,511
Shale oil.....gallons	(⁷)	(⁸)	51,946	(⁸)
Silver.....troy ounces	3,784,605	2,145,871	4,052,253	2,370,568
Stone.....short tons	⁹ 883,140	⁹ 975,953	⁹ 956,380	⁹ 933,241
Tungsten ore (60 per cent concentrates).....do	332	209,007	229	149,423
Uranium and vanadium ores.....do	(1)	(1)	(1)	(1)
Zinc.....do	35,865	4,590,656	35,731	4,359,182
Miscellaneous ¹⁰ do		19,176,739		16,433,270
Total value, eliminating duplications.....		58,855,263		58,594,688

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metals.⁷ Bureau of Mines not at liberty to publish figures.⁸ No data available.⁹ Exclusive of marble, value for which is included under "Miscellaneous."¹⁰ Includes minerals indicated by "1," "3," and "9" above.

Mineral production of Connecticut in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		^{1 2} \$2,652,640		^{1 2} \$2,558,384
Clay, raw.....short tons.....	621	³ 6,225	779	^{3 4} 5,627
Coke.....do.....			(^{3 4})	(^{3 4})
Feldspar (crude).....long tons.....	6,123	43,319	6,292	48,996
Lime.....short tons.....	53,304	608,550	48,152	529,936
Mica:				
Scrap.....do.....	(⁴)	(⁴)	(⁴)	(⁴)
Sheet.....pounds.....	(⁴)	(⁴)	(⁴)	(⁴)
Mineral waters.....gallons sold.....	(⁴)	(⁴)	(⁴)	(⁴)
Sand and gravel.....short tons.....	667,983	485,169	660,708	479,173
Sand-lime brick.....thousands.....	(^{1 4})	(^{1 4})		
Stone.....short tons.....	2,295,360	3,202,040	2,852,980	3,743,572
Miscellaneous ⁶		307,382		872,164
Total value, eliminating duplications.....		7,299,100		7,599,655

¹ Figures obtained through cooperation with Bureau of the Census.² Exclusive of pottery, value for which is included under "Miscellaneous."³ Value not included in total value for State.⁴ Value included under "Miscellaneous."⁵ No canvass.⁶ Includes minerals indicated by "2" and "4" above.*Mineral production of Delaware in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		¹ \$293,089		¹ \$274,894
Clay, raw.....short tons.....	6,561	² 82,656	5,638	² 84,736
Marl, greensand.....do.....	(³)	(³)		
Potassium salts.....do.....	(^{3 4})	(^{3 4})		
Sand and gravel.....do.....	61,177	42,338	68,615	50,209
Stone.....do.....	(³)	(³)	(³)	(³)
Miscellaneous.....		159,435		156,481
Total value, eliminating duplications.....		493,377		481,584

¹ Figures obtained through cooperation with Bureau of the Census.² Value not included in total value for State.³ Value included under "Miscellaneous."⁴ Value not included in total value for State, as value of raw product (greensand marl) is included.*Mineral production of the District of Columbia in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		(^{1 2})		^{1 3} \$211,020
Clay, raw.....short tons.....	(^{2 4})	(^{2 4})		
Sand and gravel.....do.....	990,927	\$1,048,381	1,002,126	759,053
Sand-lime brick.....thousands.....	(^{1 2})	(^{1 2})	(^{1 2})	(^{1 2})
Stone.....short tons.....	6,630	21,350	(²)	(²)
Miscellaneous ⁶		305,228		61,143
Total value, eliminating duplications.....		1,374,719		1,031,216

¹ Figures obtained through cooperation with Bureau of the Census.² Value included under "Miscellaneous."³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁶ Includes minerals indicated by "2" and "3" above.

Mineral production of Florida in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		² \$462, 190		² \$392, 048
Clay, raw.....short tons.....	47, 319	⁴ 646, 415	46, 496	⁴ 630, 471
Diatomite.....do.....			350	42, 000
Fuller's earth.....do.....	(1)	(1)	(1)	(1)
Lime.....do.....	5, 317	59, 491	4, 748	50, 086
Mineral waters.....gallons sold.....	(9)	(9)	(9)	(9)
Peat.....short tons.....	(9)	(9)	(9)	(9)
Phosphate rock.....long tons.....	2, 637, 420	8, 646, 162	2, 883, 446	9, 424, 022
Sand and gravel.....short tons.....	1, 588, 907	930, 504	894, 879	495, 875
Sand-lime brick.....thousands.....	² 7, 102	² 74, 898	² 6, 327	² 57, 866
Stone.....short tons.....	7, 437, 580	6, 138, 767	3, 381, 470	2, 654, 370
Titanium minerals:				
Ilmenite.....do.....	(1)	(1)	(1)	(1)
Rutile.....do.....	(1)	(1)	(1)	(1)
Zircon.....do.....	3, 646	⁶ 364, 600	(1)	(1)
Miscellaneous ⁷ do.....		1, 419, 349		2, 110, 856
Total value, eliminating duplications.....		18, 095, 961		15, 227, 123

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁵ No canvass.⁶ Value estimated by the Bureau of Mines.⁷ Includes minerals indicated by "1" and "3" above.*Mineral production of Georgia in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Asbestos.....short tons.....	(1)	(1)	(1)	(1)
Barite.....do.....	94, 039	\$580, 300	112, 316	\$675, 509
Bauxite.....long tons.....	13, 050	71, 230	6, 982	35, 145
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		² 4, 879, 736		² 3, 656, 489
Clay, raw.....short tons.....	222, 938	³ 1, 537, 378	249, 604	³ 1, 687, 654
Coal.....do.....	76, 712	233, 000	58, 390	181, 000
Coke.....do.....	(1 ³)	(1 ³)	(1 ³)	(1 ³)
Fuller's earth.....do.....	(1)	(1)	100, 406	1, 572, 041
Gold.....troy ounces.....	50	1, 042	44	911
Graphite, crystalline.....pounds.....			(1)	(1)
Iron ore.....long tons.....	50, 312	147, 068	73, 052	209, 877
Lime.....short tons.....	13, 533	99, 604	12, 890	83, 045
Manganese ore.....long tons.....	489	(1)	4, 727	(1)
Manganiferous ore.....do.....	20, 210	136, 094	4, 687	41, 322
Mica:				
Scrap.....short tons.....	(1)	(1)		
Sheet.....pounds.....	(1)	(1)	5, 652	1, 344
Micaceous minerals(chlorite schist). short tons.....	(1)	(1)	(1)	(1)
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Ore (dry and siliceous) (gold and silver) short tons.....			130	(9)
Sand and gravel.....do.....	683, 366	295, 505	744, 948	310, 569
Sand-lime brick.....thousands.....	(1 ²)	(1 ²)		
Silver.....troy ounces.....	7	4	5	3
Slate.....do.....		(1)		(1)
Stone.....short tons.....	⁶ 849, 290	⁶ 6, 146, 613	⁶ 1, 028, 060	⁶ 5, 854, 226
Talc.....do.....	3, 110	42, 370	(1)	(1)
Miscellaneous ⁷ do.....		4, 139, 502		2, 122, 917
Total value, eliminating duplications.....		16, 758, 390		14, 740, 431

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Exclusive of sandstone, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "1" and "6" above.

Mineral production of Idaho in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		¹ \$205,993		¹ \$188,232
Clay, raw..... short tons.....	477	² 5,748	494	² 6,095
Coal..... do.....	(³)	(³)	(³)	(³)
Copper..... pounds.....	2,173,163	284,684	2,072,165	298,392
Diatomite..... short tons.....	(³)	(³)		
Gems and precious stones.....		(⁴)		(⁴)
Gold..... troy ounces.....	15,316	316,603	20,980	433,703
Lead..... short tons.....	151,019	19,028,421	145,323	16,857,462
Lime..... do.....	(³)	(³)	(³)	(³)
Manganese ore..... long tons.....	3,181	50,900	(³)	(³)
Ores (crude), etc.:.....				
Copper..... short tons.....	27,742	(⁵)	31,454	(⁵)
Copper-lead and copper-lead-zinc..... do.....	40,125	(⁵)	49,322	(⁵)
Dry and siliceous (gold and silver)..... do.....	5,268	(⁵)	10,571	(⁵)
Lead..... do.....	1,308,987	(⁵)	1,138,581	(⁵)
Lead-zinc..... do.....	636,203	(⁵)	823,951	(⁵)
Zinc..... do.....			450	(⁵)
Phosphate rock..... long tons.....	45,260	259,405	37,477	147,908
Sand and gravel..... short tons.....	198,091	81,238	716,471	326,278
Silver..... troy ounces.....	8,901,409	5,047,099	8,998,330	5,264,023
Stone..... short tons.....	286,410	400,160	851,540	1,157,236
Zinc..... do.....	26,778	3,427,606	31,263	3,814,126
Miscellaneous ⁶		81,820		101,861
Total value, eliminating duplications.....		29,183,929		28,589,221

¹ Figures obtained through cooperation with Bureau of the Census.² Value not included in total value for State.³ Value included under "Miscellaneous."⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Includes minerals indicated by "³" above.*Mineral production of Illinois in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement..... barrels.....	1 7,061,240	¹ \$11,312,783	1 7,405,667	¹ \$11,602,848
Clay products.....		² 34,452,605		² 32,026,885
Clay, raw..... short tons.....	198,306	³ 381,228	248,618	³ 466,290
Coal..... do.....	46,848,224	101,356,000	55,948,199	112,095,000
Coke..... do.....	3,013,940	³ 21,076,519	3,240,964	³ 19,967,463
Fluorspar..... do.....	46,006	863,909	65,884	1,154,983
Fuller's earth..... do.....	(⁴)	(⁴)	(⁴)	(⁴)
Iron, pig..... long tons.....	3,466,203	³ 66,442,068	4,094,514	³ 73,524,773
Lead..... short tons.....	277	34,902	385	44,660
Lime..... do.....	115,803	1,084,093	115,523	1,017,001
Marl, calcareous..... do.....	100	50	(⁴)	(⁴)
Mineral paints, zinc and lead pigments..... do.....	16,014	³ 2,027,696	15,986	³ 2,004,580
Mineral waters..... gallons sold.....	(⁵)	(⁵)	(⁵)	(⁵)
Natural gas..... M cubic feet.....	3,741,000	764,000	3,051,000	360,000
Natural gasoline..... gallons.....	8,853,000	532,000	7,817,000	585,000
Ores (crude), etc.: ⁶				
Lead-zinc..... short tons.....	49,000	(⁷)		
Zinc..... do.....	39,200	(⁷)		
Peat..... do.....	(⁸)	(⁸)	(⁸)	(⁸)
Petroleum..... barrels.....	6,994,000	11,700,000	6,462,000	9,980,000
Sand and gravel..... short tons.....	19,328,703	9,166,934	20,969,331	10,243,555
Sand and sandstone (finely ground)..... do.....	(⁴)	(⁴)	(⁴)	(⁴)
Sand-lime brick..... thousands.....	(² ⁴)	(² ⁴)		
Silver..... troy ounces.....	1,518	861	3,146	1,840
Stone..... short tons.....	9,699,530	8,127,506	9,728,920	8,098,390
Sulphuric acid (60° Baumé) ⁸ do.....	241,025	³ 2,352,000	253,335	³ 2,505,483
Tripoli..... do.....	(⁴)	(⁴)	(⁴)	(⁴)
Zinc..... do.....	521	66,688	17	2,074
Miscellaneous ⁹		931,448		886,630
Total value, eliminating duplications.....		180,393,779		188,098,866

¹ Exclusive of natural cement, value for which is included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ Value included under "Miscellaneous."⁵ No canvass.⁶ Figures cover Northern Illinois only; lead output of Southern Illinois is by-product of fluorspar milling.⁷ Not valued as ore; value of recoverable metal content included under the metals.⁸ From zinc smelting.⁹ Includes minerals indicated by "¹" and "⁴" above.

Mineral production of Indiana in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		² \$17,855,971		² \$16,546,711
Clay, raw.....short tons.....	163,593	³ 206,361	170,512	³ 202,215
Coal.....do.....	17,935,758	36,381,000	16,378,580	29,212,000
Coke.....do.....	5,549,762	³ 37,152,981	6,094,201	³ 38,237,790
Iron, pig.....long tons.....	3,447,764	³ 62,097,518	3,842,762	³ 63,622,330
Lime.....short tons.....	116,171	830,527	107,209	734,915
Mineral paints, zinc and lead pigments.....do.....	(1 ³)	(1 ³)	(1 ³)	(1 ³)
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Natural gas.....M cubic feet.....	1,124,000	509,000	1,290,000	639,000
Peat.....short tons.....	(4)	(4)	(4)	(4)
Petroleum.....barrels.....	852,000	1,390,000	1,052,000	1,580,000
Potassium salts.....short tons.....			(1)	(1)
Rubbing stones, scythestones, and whetstones.....short tons.....	285	37,461	171	23,994
Sand and gravel.....do.....	11,870,658	5,552,804	11,086,331	5,375,058
Sand-lime brick.....thousands.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Stone.....short tons.....	5,813,000	22,634,359	⁵ 5,102,280	⁵ 22,720,411
Sulphuric acid ⁴ do.....	(1 ³)	(1 ³)	(1 ³)	(1 ³)
Miscellaneous ⁷ do.....		24,808,283		24,395,264
Total value, eliminating duplications.....		107,578,234		98,583,915

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ No canvass.⁵ Exclusive of unclassified stone, value for which is included under "Miscellaneous."⁶ From zinc smelting.⁷ Includes minerals indicated by "1" and "3" above.*Mineral production of Iowa in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels.....	5,661,234	\$9,124,405	6,880,731	\$10,734,838
Clay products.....		^{1 2} 5,158,104		^{1 2} 5,006,623
Clay, raw.....short tons.....	2,463	³ 16,516	4,054	³ 23,500
Coal.....do.....	2,949,622	9,304,000	3,683,635	10,525,000
Ferro-alloys.....long tons.....	(³ 4)	(³ 4)	(⁴ 4)	(³ 4)
Gypsum.....short tons.....	792,159	6,713,497	764,044	5,355,214
Lime.....do.....	(4)	(4)	(4)	(4)
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Sand and gravel.....short tons.....	3,981,143	1,839,176	3,423,619	2,094,955
Stone.....do.....	1,274,380	1,231,546	1,666,270	1,742,252
Miscellaneous ⁶ do.....		1,235,257		1,191,945
Total value, eliminating duplications.....		33,426,375		35,498,669

¹ Figures obtained through cooperation with Bureau of the Census.² Exclusive of pottery, value for which is included under "Miscellaneous."³ Value not included in total value for State.⁴ Value included under "Miscellaneous."⁵ No canvass.⁶ Includes minerals indicated by "2" and "4" above.

Mineral production of Kansas in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels..	¹ 6, 141, 937	¹ \$9, 939, 412	¹ 6, 787, 568	¹ \$10, 091, 330
Chats.....short tons..	150, 000	17, 500	99, 000	19, 000
Clay products.....		² ³ 3, 805, 509		² ³ 3, 593, 130
Coal.....short tons..	3, 443, 762	9, 648, 000	2, 809, 724	6, 861, 000
Gypsum.....do.....	175, 351	975, 649	126, 227	935, 595
Lead.....do.....	27, 497	3, 464, 622	25, 276	2, 932, 016
Mineral paints, zinc and lead pigments..do.....	(⁴ ⁵)	(⁴ ⁵)	(⁴ ⁵)	(⁴ ⁵)
Mineral waters.....gallons sold..	(⁶)	(⁶)	(⁶)	(⁶)
Natural gas.....M cubic feet..	42, 646, 000	12, 833, 000	45, 644, 000	14, 144, 000
Natural gasoline.....gallons..	36, 095, 000	1, 746, 000	36, 765, 000	2, 444, 000
Ores (crude), etc.:				
Lead.....short tons..	4, 700	(⁷)	5, 500	(⁷)
Lead-zinc.....do.....	3, 480, 400	(⁷)	3, 083, 700	(⁷)
Zinc.....do.....	1, 020, 700	(⁷)	1, 573, 000	(⁷)
Petroleum.....barrels..	41, 069, 000	58, 300, 000	38, 596, 000	52, 500, 000
Pumice.....short tons..	45, 439	152, 748	46, 836	183, 589
Salt.....do.....	794, 780	2, 971, 544	821, 950	3, 573, 982
Sand and gravel.....do.....	2, 254, 648	1, 456, 130	2, 760, 277	1, 532, 399
Stone.....do.....	801, 450	922, 532	⁸ 1, 203, 270	⁸ 1, 212, 598
Zinc.....do.....	109, 427	14, 006, 656	107, 251	13, 084, 622
Miscellaneous ⁹		1, 802, 024		1, 978, 980
Total value, eliminating duplications.....		120, 368, 526		113, 279, 524

¹ Exclusive of natural cement, value for which is included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value included under "Miscellaneous."⁵ Value not included in total value for State.⁶ No canvass.⁷ Not valued as ore; value of recoverable metal content included under the metals.⁸ Exclusive of sandstone, value for which is included under "Miscellaneous."⁹ Includes minerals indicated by "1," "2," "4," and "8" above.*Mineral production of Kentucky in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Asphalt (native).....short tons..	344, 220	\$3, 156, 700	318, 548	\$2, 757, 547
Cement.....barrels..	(¹)	(¹)	(¹)	(¹)
Clay products.....		² ³ 7, 257, 664		² ³ 7, 113, 523
Clay, raw.....short tons..	119, 829	⁴ 662, 149	149, 317	⁴ 757, 505
Coal.....do.....	69, 123, 998	119, 249, 000	61, 860, 379	96, 722, 000
Coke.....do.....	(¹ ⁴)	(¹ ⁴)	(¹ ⁴)	(¹ ⁴)
Fluorspar.....do.....	57, 495	1, 040, 338	69, 747	1, 426, 766
Iron, pig.....long tons..	184, 851	(¹ ⁴)	225, 545	(¹ ⁴)
Lead.....short tons..	139	17, 514	39	4, 524
Lime.....do.....	6, 862	47, 620	(¹)	(¹)
Mineral waters.....gallons sold..	(⁵)	(⁵)	(⁵)	(⁵)
Natural gas.....M cubic feet..	10, 206, 000	3, 277, 000	15, 383, 000	5, 349, 000
Natural gasoline.....gallons..	7, 480, 000	547, 000	7, 267, 000	575, 000
Ores (lead and zinc).....short tons..	(⁶)	(⁶)	(⁶)	(⁶)
Petroleum.....barrels..	6, 719, 000	11, 220, 000	7, 359, 000	11, 850, 000
Sand and gravel.....short tons..	3, 002, 311	1, 718, 055	2, 100, 997	1, 589, 617
Stone.....do.....	2, 603, 770	2, 863, 779	2, 710, 360	2, 892, 426
Zinc.....do.....	860	110, 080	92	11, 224
Miscellaneous ⁷		8, 407, 996		7, 883, 574
Total value, eliminating duplications.....		152, 614, 177		131, 969, 907

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁵ No canvass.⁶ Figures not available.⁷ Includes minerals indicated by "1" and "3" above.

Mineral production of Louisiana in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels..	(1)	(1)	(1)	(1)
Clay products.....		^{2 3} \$446, 156		^{2 3} \$284, 114
Mineral waters.....gallons sold..	(4)	(4)	(4)	(4)
Natural gas.....M cubic feet..	186, 961, 000	12, 158, 000	227, 821, 000	20, 279, 000
Natural gasoline.....gallons..	44, 844, 000	2, 442, 000	55, 022, 000	3, 434, 000
Petroleum.....barrels..	22, 818, 000	29, 740, 000	21, 847, 000	25, 850, 000
Salt.....short tons..	606, 110	2, 167, 220	630, 780	2, 405, 351
Sand and gravel.....do..	2, 723, 112	1, 910, 064	2, 310, 166	1, 503, 400
Sand-lime brick.....thousands..	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Stone.....short tons..	115, 450	169, 643	(1)	(1)
Sulphur.....long tons..	(1)	(1)	(1)	(1)
Miscellaneous ⁵		2, 233, 838		3, 054, 538
Total value, eliminating duplications.....		51, 266, 921		56, 810, 403

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ No canvass.⁵ Includes minerals indicated by "1" and "3" above.*Mineral production of Maine in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels..			373, 102	\$637, 643
Clay products.....		¹ \$680, 739		¹ 535, 088
Clay, raw.....short tons..	266	² 3, 392	173	² 1, 884
Feldspar (crude).....long tons..	34, 328	299, 386	25, 063	202, 219
Gems and precious stones.....		(³)		(³)
Lime.....short tons..	116, 566	1, 230, 356	123, 023	1, 056, 443
Lithium minerals.....do..	(4)	(4)		
Marl, calcareous.....do..	500	4, 250	500	4, 250
Mica:				
Scrap.....do..	(4)	(4)	(4)	(4)
Sheet.....pounds..	(4)	(4)	(4)	(4)
Mineral waters.....gallons sold..	(3)	(3)	(3)	(3)
Peat.....short tons..	(3)	(3)	(3)	(3)
Sand and gravel.....do..	584, 395	251, 448	758, 528	348, 376
Silica (quartz).....do..	(4)	(4)		
Slate.....		549, 952		551, 242
Stone.....short tons..	355, 800	2, 447, 644	413, 960	2, 579, 523
Miscellaneous ⁴		11, 920		7, 945
Total value, eliminating duplications.....		5, 475, 695		5, 922, 729

¹ Figures obtained through cooperation with Bureau of the Census.² Value not included in total value for State.³ No canvass.⁴ Value included under "Miscellaneous."⁵ Includes minerals indicated by "4" above

Mineral production of Maryland in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Asbestos.....short tons.....	(1)	(1)	(1)	(1)
Briquets, fuel.....do.....	(1 2)	(1 2)	(1 2)	(1 2)
Cement.....barrels.....	(1)	(1)	(1)	(1)
Chromite.....long tons.....			8	\$165
Clay products.....		³ \$2,503,935		³ 4,586,625
Clay, raw.....short tons.....	38,551	² 102,690	60,762	² 91,547
Coal.....do.....	2,814,842	5,817,000	2,686,979	4,954,000
Coke.....do.....	1,077,309	(1 2)	1,186,398	(1 2)
Diatomite.....do.....	80	800		
Feldspar (crude).....long tons.....	2,001	11,612	2,349	10,325
Ferro-alloys.....do.....	(1 2)	(1 2)		
Iron, pig.....do.....	845,564	(1 2)	971,832	(1 2)
Lime.....short tons.....	55,405	439,457	59,508	440,886
Marl, calcareous.....do.....	2,452	9,499		
Mineral waters.....gallons sold.....	(9)	(9)	(9)	(9)
Potassium salts.....short tons.....	(1)	(1)	(1)	(1)
Sand and gravel.....do.....	2,914,448	2,185,248	2,602,142	2,409,544
Silica (quartz).....do.....	4,409	37,717	3,515	10,466
Slate.....do.....		205,812		187,830
Stone.....short tons.....	1,214,110	2,039,243	⁶ 926,850	⁶ 1,692,111
Talc.....do.....	(1)	(1)	(1)	(1)
Miscellaneous ⁷		28,342,638		27,496,564
Total value, eliminating duplications.....		20,469,294		18,417,781

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ No canvass.⁶ Exclusive of marble, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "1," "4," and "6" above.*Mineral production of Massachusetts in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Briquets, fuel.....short tons.....	(1 2)	(1 2)	(1 2)	(1 2)
Clay products.....		³ \$2,398,474		³ \$2,829,610
Clay, raw.....short tons.....	1,626	² 23,240	2,158	² 11,848
Coke.....do.....	744,091	² 6,008,556	687,356	² 5,269,890
Fuller's earth.....do.....	(1)	(1)	(1)	(1)
Iron, pig.....long tons.....	129,039	(1 2)	(1 2)	(1 2)
Lime.....short tons.....	189,343	2,325,031	171,944	2,026,019
Manganiferous ore.....long tons.....	(1)	(1)		
Mineral waters.....gallons sold.....	(9)	(9)	(9)	(9)
Sand and gravel.....short tons.....	2,646,335	2,495,696	3,751,193	2,986,850
Sand-lime brick.....thousands.....	(1 3)	(1 3)	(1 3)	(1 3)
Silica (quartz).....short tons.....	(1)	(1)	(1)	(1)
Stone.....do.....	⁶ 2,629,890	⁶ 7,291,969	⁶ 2,879,990	⁶ 7,732,247
Miscellaneous ⁷		4,343,124		3,784,035
Total value, eliminating duplications.....		16,295,373		16,234,037

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ No canvass.⁶ Exclusive of sandstone, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "1," "4," and "6" above.

Mineral production of Michigan in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Bromine.....pounds.....	(1)	(1)	(1)	(1)
Calcium chloride.....short tons.....	(1)	(1)	(1)	(1)
Cement.....barrels.....	13,708,259	\$20,858,202	14,044,230	\$19,268,707
Clay products.....		² 6,772,283		² 6,310,586
Clay, raw.....short tons.....	3,539	³ 6,620	3,805	³ 6,949
Coal.....do.....	756,763	3,262,000	617,342	2,631,000
Coke.....do.....	1,920,394	³ 12,227,241	2,399,656	³ 13,461,466
Copper.....pounds.....	177,537,775	23,257,449	178,442,704	25,695,749
Ferro-alloys.....long tons.....	2,415	(1 ³)	(1 ³)	(1 ³)
Gems and precious stones.....		(4)		(4)
Graphite, amorphous.....short tons.....	(1)	(1)	(1)	(1)
Grindstones.....do.....	(1)	(1)		
Gypsum.....do.....	668,617	4,216,524	677,108	3,159,369
Iron ore:				
Sold to furnaces.....long tons.....	14,532,831	37,135,364	14,241,102	37,039,644
Sold for paint.....do.....	2,045	(1)	1,950	(1)
Iron, pig.....do.....	626,532	³ 12,527,993	797,776	³ 15,157,535
Lime.....short tons.....	101,172	931,597	104,917	962,708
Magnesium.....pounds.....	219,950	³ 163,300	483,000	³ 587,000
Magnesium chloride (natural).....do.....	(1)	(1)	(1)	(1)
Magnesium sulphate (natural).....do.....	(1)	(1)	(1)	(1)
Manganiferous ore.....long tons.....	74,739	(1)	49,204	131,940
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Natural gas.....M cubic feet.....	600	300	469,000	149,000
Ore (copper).....short tons.....	8,046,334	(4)	7,361,658	(4)
Peat.....do.....	(4)	(4)	(4)	(4)
Petroleum.....barrels.....	439,000	832,000	594,000	920,000
Salt.....short tons.....	2,271,460	7,551,552	2,405,240	8,249,437
Sand and gravel.....do.....	15,419,499	7,800,541	15,893,090	6,828,431
Sand-lime brick.....thousands.....	² 112,181	² 1,402,647	² 103,056	² 1,270,778
Silver.....troy ounces.....	97,193	55,109	17,153	10,035
Stone.....short tons.....	⁶ 11,442,780	⁶ 6,560,946	12,472,600	7,588,480
Miscellaneous ⁷		3,481,205		3,335,611
Total value, eliminating duplications.....		124,029,572		123,535,869

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Exclusive of sandstone, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "1" and "6" above.*Mineral production of Minnesota in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		² ³ \$1,675,662		² ³ \$1,492,792
Clay, raw.....short tons.....	17,287	⁴ 40,640	18,566	⁴ 43,437
Coke.....do.....	632,628	⁴ 6,212,501	622,696	⁴ 5,816,566
Flint lining for tube mills.....do.....	(1)	(1)	(1)	(1)
Gems and precious stones.....		(4)		(4)
Iron ore.....long tons.....	35,563,177	87,935,099	38,129,018	94,258,899
Iron, pig.....do.....	287,813	(1 ⁴)	341,203	(1 ⁴)
Lime.....short tons.....	(1)	(1)	(1)	(1)
Manganiferous ore.....long tons.....	940,875	2,192,051	1,028,501	(1)
Marl, calcareous.....short tons.....		(1)		(1)
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Pebbles for grinding.....short tons.....	(1)	(1)	(1)	(1)
Sand and gravel.....do.....	3,515,554	2,171,625	4,409,245	2,029,091
Sand-lime brick.....thousands.....	² 16,186	² 171,753	(1 ³)	(1 ²)
Stone.....short tons.....	802,340	4,259,766	⁶ 474,450	⁶ 3,699,498
Miscellaneous ⁷		9,881,765		12,741,370
Total value, eliminating duplications.....		102,972,753		108,274,963

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁵ No canvass.⁶ Exclusive of unclassified stone, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "1," "3," and "6" above.

Mineral production of Mississippi in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		^{1 2} \$1, 146, 472		¹ \$1, 129, 799
Clay, raw..... short tons.....	2, 805	³ 20, 308	1, 320	³ 2, 310
Mineral waters..... gallons sold.....	(⁴)	(⁴)	(⁴)	(⁴)
Natural gas..... M cubic feet.....	(⁴)	(⁴)	(⁴)	(⁴)
Sand and gravel..... short tons.....	3, 122, 401	1, 372, 089	3, 012, 291	1, 428, 548
Stone..... do.....	(⁴)	(⁴)	(⁴)	(⁴)
Miscellaneous ⁴		35, 072		76, 000
Total value, eliminating duplications.....		2, 553, 633		2, 634, 347

¹ Figures obtained through cooperation with Bureau of the Census.² Exclusive of pottery, value for which is included under "Miscellaneous."³ Value not included in total value for State.⁴ No canvass.⁵ Value included under "Miscellaneous."⁶ Includes minerals indicated by "2" and "8" above.*Mineral production of Missouri in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Barite..... short tons.....	111, 456	\$797, 465	114, 274	\$810, 203
Briquets, fuel..... do.....	(^{1 2})	(^{1 2})	(^{1 2})	(^{1 2})
Cement..... barrels.....	6, 929, 229	11, 117, 047	7, 943, 367	12, 367, 018
Chats..... short tons.....	2, 107, 620	526, 933	1, 904, 000	476, 000
Clay products.....		³ 16, 392, 171		^{3 4} 14, 891, 273
Clay, raw..... short tons.....	416, 490	² 1, 693, 792	426, 026	² 1, 442, 644
Coal..... do.....	3, 064, 343	8, 698, 000	3, 732, 421	9, 637, 000
Coke..... do.....	(^{1 2})	(^{1 2})	(^{1 2})	(^{1 2})
Copper..... pounds.....	451, 000	59, 081	65, 000	9, 360
Iron ore..... long tons.....	78, 605	315, 670	94, 899	377, 847
Lead..... short tons.....	198, 760	25, 043, 760	195, 393	22, 665, 588
Lime..... do.....	267, 776	2, 189, 420	303, 014	2, 252, 420
Mineral paints, zinc and lead pigments..... do.....	(^{1 2})	(^{1 2})	(^{1 2})	(^{1 2})
Mineral waters..... gallons sold.....	(⁴)	(⁴)	(⁴)	(⁴)
Natural gas..... M cubic feet.....	300	200	360, 000	217, 000
Ores (crude), etc.:				
Lead..... short tons.....	6, 337, 500	(⁴)	6, 305, 500	(⁴)
Lead-zinc..... do.....	231, 700	(⁴)	112, 300	(⁴)
Zinc..... do.....	254, 800	(⁴)	156, 000	(⁴)
Sand and gravel..... do.....	4, 829, 473	2, 875, 530	5, 251, 226	3, 248, 813
Sand and sandstone (finely ground)..... do.....	(¹)	(¹)	(¹)	(¹)
Sand-lime brick..... thousands.....	(^{1 3})	(^{1 3})	(^{1 3})	(^{1 3})
Silver..... troy ounces.....	233, 931	132, 638	176, 840	103, 451
Stone..... short tons.....	⁷ 3, 064, 600	⁷ 5, 170, 859	3, 445, 690	6, 137, 631
Tripoli..... do.....	(¹)	(¹)	(¹)	(¹)
Tungsten ore (60 per cent concentrates)..... do.....				
Zinc..... do.....	18, 737	2, 398, 336	12, 974	1, 582, 828
Miscellaneous ⁸		4, 017, 412		3, 893, 827
Total value, eliminating duplications.....		75, 890, 415		74, 981, 382

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metals.⁷ Exclusive of unclassified stone, value for which is included under "Miscellaneous."⁸ Includes minerals indicated by "1," "4," and "7" above.

Mineral production of Montana in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Arsenious oxide.....short tons.	7,329	\$397,404	7,120	\$431,700
Asbestos.....do.	(1)	(1)	(1)	(1)
Cement.....barrels.	(1)	(1)	(1)	(1)
Clay products.....		² 299,622		² 397,516
Clay, raw.....short tons.	13,207	³ 24,231	24,543	³ 73,103
Coal.....do.	3,143,638	7,403,000	3,324,195	7,550,000
Copper.....pounds.	223,492,639	29,277,536	248,262,027	35,749,732
Ferro-alloys.....long tons.	(1 ³)	(1 ³)	(1 ³)	(1 ³)
Gems and precious stones.....		(1)		(1)
Gold.....troy ounces.	53,541	1,106,796	58,196	1,203,020
Graphite, crystalline.....pounds.	(1)	(1)		
Gypsum.....short tons.	(1)	(1)	(1)	(1)
Iron ore.....long tons.	2,837	10,156	1,640	5,900
Lead.....short tons.	17,949	2,261,594	16,880	1,958,059
Lime.....do.	11,607	90,512	(1)	(1)
Manganese ore.....long tons.	26,506	836,675	26,733	(1)
Manganiferous ore.....do.	10,332	(1)	11,156	(1)
Micaceous minerals (vermiculite).....short tons.	(1)	(1)	1,005	38,054
Mineral waters.....gallons sold.	(1)	(1)	(1)	(1)
Natural gas.....M cubic feet.	4,253,100	716,400	6,277,000	1,446,000
Ores (crude), etc.:				
Copper.....short tons.	2,958,445	(1)	3,174,509	(1)
Copper-lead.....do.	263,868	(1)	192,839	(1)
Dry and siliceous (gold and silver).....do.	111,976	(1)	112,331	(1)
Lead.....do.	57,182	(1)	10,419	(1)
Lead-zinc.....do.	498,732	(1)	764,776	(1)
Zinc.....do.	332,404	(1)	89,405	(1)
Petroleum.....barrels.	5,058,000	7,090,000	4,015,000	6,400,000
Sand and gravel.....short tons.	2,187,934	910,513	1,430,914	465,375
Silver.....troy ounces.	11,200,077	6,350,444	10,853,276	6,349,166
Stone.....short tons.	219,510	191,021	235,180	234,334
Sulphuric acid (60° Baumé) ⁶ do.	34,317	(1 ³)	38,298	(1 ³)
Tungsten ore (60 per cent concentrates).....do.	(1)	(1)		
Zinc.....do.	80,231	10,269,555	82,830	10,105,272
Miscellaneous ⁷		1,242,280		2,832,642
Total value, eliminating duplications.....		68,264,687		74,752,309

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ From copper smelting.⁷ Includes minerals indicated by "1" above.*Mineral production of Nebraska in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels.	(1)	(1)	(1)	(1)
Clay products.....		² \$819,494		² \$794,851
Clay, raw.....short tons.	4,131	⁴ 4,759	19,152	⁴ 19,731
Mineral waters.....gallons sold.	(1)	(1)	(1)	(1)
Pumice.....short tons.	(1)	(1)	(1)	(1)
Sand and gravel.....do.	2,420,364	1,370,605	2,234,575	1,265,001
Stone.....do.	170,500	352,222	234,590	399,971
Miscellaneous ⁶		1,019,471		¹ 994,877
Total value, eliminating duplications.....		3,541,792		3,454,700

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁵ No canvass.⁶ Includes minerals indicated by "1" and "3" above.

Mineral production of Nevada in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Antimony ore.....short tons.....			30	(1)
Barite.....do.....	884	\$3,969		
Borates.....do.....	(1)	(1)	(1)	(1)
Clay products.....do.....		(1) ²		(1) ²
Clay, raw.....short tons.....	5,910	³ 36,458	13,509	⁴ \$61,523
Coal.....do.....	(1)	(1)		
Copper.....pounds.....	120,259,276	15,753,965	158,876,883	22,878,271
Diatomite.....short tons.....	344	5,924	663	10,522
Fluorspar.....do.....			455	(1)
Fuller's earth.....do.....	32,903	348,070	45,157	444,267
Gems and precious stones.....do.....		(1)		(1)
Gold.....troy ounces.....	150,346	3,107,931	175,158	3,620,833
Graphite, amorphous.....short tons.....	(1)	(1)	(1)	(1)
Gypsum.....do.....	327,365	1,484,171	278,405	1,424,455
Lead.....do.....	7,892	994,444	7,874	913,352
Lime.....do.....	(1)	(1)	(1)	(1)
Manganese ore.....long tons.....	1,357	16,976		
Manganiferous ore:				
For fluxing.....do.....	2,161	(1)	1,602	(1)
For other purposes.....do.....	3,310	(1)		
Mercury.....flasks.....	425	49,555	2,905	354,061
Mica, sheet.....pounds.....	(1)	(1)		
Mineral waters.....gallons sold.....	(1)	(1)	(1)	(1)
Ores (crude), etc.:				
Copper.....short tons.....	4,885,052	(1)	6,244,047	(1)
Copper-lead.....do.....	25,304	(1)	40,329	(1)
Dry and siliceous (gold and silver).....do.....	515,825	(1)	641,004	(1)
Lead.....do.....	75,924	(1)	101,416	(1)
Lead-zinc.....do.....	27,582	(1)	30,603	(1)
Zinc.....do.....	1,465	(1)	34	(1)
Salt.....do.....	(1)	(1)	(1)	(1)
Sand and gravel.....do.....	462,574	187,150	201,992	150,966
Silica (quartz).....do.....	1,030	6,180	(1)	(1)
Silver.....troy ounces.....	5,397,179	3,060,200	5,481,574	3,206,721
Sodium sulphate from natural sources.....short tons.....	(1)	(1)	(1)	(1)
Stone.....do.....	700,710	570,508	⁵ 824,910	⁶ 601,664
Sulphur.....long tons.....	(1)	(1)	(1)	(1)
Tungsten ore (60 per cent concentrates).....short tons.....	372	(1)	551	(1)
Uranium and vanadium ores.....do.....			(1)	(1)
Zinc.....do.....	3,172	406,049	3,398	414,599
Miscellaneous ⁷ do.....		758,203		862,076
Total value, eliminating duplications.....		26,753,295		34,881,787

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Exclusive of limestone, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "1" and "6" above.*Mineral production of New Hampshire in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		¹ \$811,626		¹ \$881,023
Diatomite.....short tons.....	7	455	10	650
Feldspar (crude).....long tons.....	27,449	223,077	30,343	236,224
Garnet, abrasive.....short tons.....	(1)	(1)	(1)	(1)
Mica:				
Scrap.....do.....	1,284	22,909	1,291	25,232
Sheet.....pounds.....	720,219	78,849	774,143	63,470
Millstones.....do.....		1,025		1,779
Mineral waters.....gallons sold.....	(1)	(1)	(1)	(1)
Sand and gravel.....short tons.....	863,618	653,214	1,636,621	1,018,547
Scythestones.....do.....	(1)	(1)	(1)	(1)
Silica (quartz).....do.....	(1)	(1)	376	2,593
Stone.....do.....	⁴ 178,300	⁴ 1,584,262	⁴ 166,040	⁴ 1,423,426
Miscellaneous ⁵ do.....		71,688		163,121
Total value, eliminating duplications.....		3,447,105		3,816,065

¹ Figures obtained through cooperation with Bureau of the Census.² Value included under "Miscellaneous."³ No canvass.⁴ Exclusive of unclassified stone, value for which is included under "Miscellaneous."⁵ Includes minerals indicated by "1" and "6" above.

Mineral production of New Jersey in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Briquets, fuel.....short tons..	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Cement.....barrels..	(1)	(1)	(1)	(1)
Clay products.....		³ \$43,099, 769		³ \$39,379, 278
Clay, raw.....short tons..	312, 410	² 1, 270, 572	260, 742	² 1, 133, 848
Coke.....do.....	906, 321	(1 ²)	903, 177	(1 ²)
Ferro-alloys.....long tons..	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Graphite, crystalline.....pounds..			(1)	(1)
Iron ore:				
Sold to furnaces.....long tons..	202, 720	860, 393	350, 616	1, 357, 877
Sold for paint.....do.....	(1)	(1)	(1)	(1)
Lime.....short tons..	(1)	(1)	(1)	(1)
Manganiferous residuum ⁴ long tons..	(1)	(1)	171, 107	(1)
Marl, greensand.....short tons..	11, 259	163, 048	12, 965	206, 582
Mineral waters.....gallons sold..	(⁵)	(⁵)	(⁵)	(⁵)
Ore (zinc).....short tons..	629, 108	(⁵)	648, 797	(⁵)
Peat.....do.....	(⁵)	(⁵)	(⁵)	(⁵)
Sand and gravel.....do.....	4, 627, 159	3, 602, 289	6, 292, 636	4, 261, 390
Sand and sandstone (finely ground).....do.....	(1)	(1)	40, 496	162, 977
Sand-lime brick.....thousands..	(1 ³)	(1 ³)	(1 ³)	(1 ³)
Stone.....short tons..	2, 760, 880	4, 334, 526	3, 186, 940	4, 578, 642
Talc.....do.....	(1)	(1)		
Zinc.....do.....	95, 695	(1)	99, 871	(1)
Miscellaneous ⁷		28, 624, 304		28, 232, 969
Total value, eliminating duplications.....		73, 090, 810		70, 865, 363

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Ore mined in New Jersey; smelted in Pennsylvania.⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metal.⁷ Includes minerals indicated by "1" above.*Mineral production of New Mexico in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		¹ \$161, 666		¹ \$166, 351
Clay, raw.....short tons..	8, 196	² 17, 414	5, 338	² 6, 597
Coal.....do.....	2, 935, 539	9, 179, 000	2, 711, 851	8, 636, 000
Copper.....pounds..	74, 251, 863	9, 726, 994	89, 854, 646	12, 939, 069
Fluorspar.....short tons..	2, 613	(³)	2, 589	(³)
Gems and precious stones.....		(1)		(1)
Gold.....troy ounces..	29, 242	604, 483	32, 912	680, 360
Gypsum.....short tons..	(³)	(³)	(³)	(³)
Iron ore.....long tons..	214, 747	(³)	184, 623	(³)
Lead.....short tons..	8, 026	1, 011, 330	7, 805	905, 409
Lime.....do.....	2, 042	20, 480	2, 002	19, 665
Lithium minerals.....do.....	(³)	(³)	(³)	(³)
Manganese ore.....long tons..	2, 190	37, 237	2, 627	(³)
Manganiferous ore.....do.....	87, 334	(³)	55, 331	(³)
Mica:				
Scrap.....short tons..	776	12, 741	1, 328	23, 426
Sheet.....pounds..	(³)	(³)	1, 822	2, 266
Mineral waters.....gallons sold..	(⁴)	(⁴)	(⁴)	(⁴)
Molybdenum.....pounds..	(³)	(³)	(³)	(³)
Natural gas.....M cubic feet..	1, 019, 000	48, 500	838, 000	66, 000
Natural gasoline.....gallons..	1, 827, 000	109, 000	1, 506, 000	107, 000
Ores (crude), etc.:				
Copper.....short tons..	3, 124, 447	(⁵)	3, 733, 442	(⁵)
Copper-lead.....do.....	2, 893	(⁵)		
Dry and siliceous (gold and silver).....do.....	31, 692	(⁵)	7, 016	(⁵)
Lead.....do.....	10, 678	(⁵)	13, 211	(⁵)
Lead-zinc.....do.....	215, 138	(⁵)	249, 233	(⁵)
Zinc.....do.....	57, 336	(⁵)	71, 072	(⁵)
Petroleum.....barrels..	1, 226, 000	1, 680, 000	943, 000	1, 280, 000
Pumice.....short tons..	25	125		
Salt.....do.....	(³)	(³)	(³)	(³)
Sand and gravel.....do.....	360, 020	226, 990	187, 239	111, 296
Silver.....troy ounces..	890, 083	504, 677	827, 793	484, 259
Stone.....short tons..	(³)	(³)	(³)	(³)
Zinc.....do.....	29, 802	3, 814, 592	31, 203	3, 806, 766
Miscellaneous ⁶		1, 470, 961		1, 198, 973
Total value, eliminating duplications.....		28, 608, 776		30, 426, 840

¹ Figures obtained through cooperation with Bureau of the Census.² Value not included in total value for State.³ Value included under "Miscellaneous."⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Includes minerals indicated by "3" above.

Mineral production of New York in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Aluminum.....pounds..	(1 2)	(1 2)	(1 2)	(1 2)
Cement.....barrels..	³ 10, 531, 092	³ \$16, 380, 090	³ 10, 983, 950	³ \$16, 748, 773
Clay products.....		⁴ 25, 476, 896		⁴ 22, 474, 405
Clay, raw.....short tons..	7, 411	² 51, 112	7, 214	² 37, 201
Coke.....do..	3, 602, 642	² 24, 125, 451	3, 802, 657	² 25, 033, 649
Diatomite.....do..	216	14, 846	182	12, 959
Emery.....do..	(1)	(1)	768	8, 192
Feldspar (crude).....long tons..	12, 020	96, 446	13, 971	120, 559
Ferro-alloys.....do..	114, 242	² 12, 138, 392	209, 688	² 17, 441, 639
Garnet, abrasive.....short tons..	(1)	(1)	(1)	(1)
Graphite, artificial.....pounds..	12, 257, 239	(1 2)	(1 2)	(1 2)
Gypsum.....short tons..	1, 675, 501	14, 889, 390	1, 504, 826	9, 613, 307
Iron ore:				
Sold to furnaces.....long tons..	936, 850	4, 568, 224	767, 743	2, 906, 055
Sold for paint.....do..	(1)	(1)	(1)	(1)
Iron, pig.....do..	2, 401, 432	² 40, 803, 579	2, 369, 814	² 39, 928, 060
Lime.....short tons..	98, 071	905, 116	93, 354	794, 301
Magnesium.....pounds..	146, 450	² 278, 400		
Marl, calcareous.....short tons..	38	73		
Millstones.....		26, 015		26, 224
Mineral waters.....gallons sold..	(5)	(5)	(5)	(5)
Natural gas.....M cubic feet..	5, 908, 000	3, 841, 000	7, 224, 000	4, 827, 000
Natural gasoline.....gallons..	449, 000	38, 000	392, 000	45, 000
Ores (crude), etc.:				
Zinc.....short tons..	43, 480	(5)	125, 192	(5)
Peat.....do..	(5)	(5)	(5)	(5)
Petroleum.....barrels..	2, 242, 000	7, 110, 000	2, 603, 000	8, 750, 000
Salt.....short tons..	1, 964, 080	6, 121, 461	2, 085, 230	6, 400, 933
Sand and gravel.....do..	19, 896, 766	12, 157, 612	21, 109, 864	12, 572, 634
Sand-lime brick.....thousands..	⁴ 10, 991	⁴ 146, 414	(1 4)	(1 4)
Silica (quartz).....short tons..	520	2, 597	(1)	(1)
Slate.....		802, 437		1, 052, 363
Stone.....short tons..	⁷ 10, 651, 610	⁷ 15, 830, 959	⁷ 10, 743, 470	⁷ 15, 785, 511
Talc.....do..	94, 553	1, 191, 453	107, 321	1, 504, 103
Zinc.....do..	3, 750	480, 000	11, 257	1, 373, 354
Miscellaneous ⁸ do..		30, 248, 904		31, 932, 757
Total value, eliminating duplications.....		112, 209, 533		108, 025, 720

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Exclusive of natural cement, value for which is included under "Miscellaneous."⁴ Figures obtained through cooperation with Bureau of the Census.⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metal.⁷ Exclusive of basalt, value for which is included under "Miscellaneous."⁸ Includes minerals indicated by "1," "3," and "7" above.

Mineral production of North Carolina in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Aluminum.....pounds..	(1 2)	(1 2)	(1 2)	(1 2)
Clay products.....		¹ \$3, 860, 950		¹ \$3, 826, 493
Clay, raw.....short tons..	20, 384	² 327, 688	19, 898	² 298, 951
Coal.....do.....	53, 377	191, 000	60, 860	201, 000
Copper.....pounds.....	5, 443, 115	713, 048	8, 207, 000	1, 181, 808
Feldspar (crude).....long tons..	100, 756	612, 214	105, 560	630, 042
Gems and precious stones.....		(4)		(4)
Gold.....troy ounces.....	49	1, 015	114	2, 366
Iron ore.....long tons.....	32, 528	81, 753		
Lime.....short tons.....	(1)	(1)	(1)	(1)
Manganese ore.....long tons.....			10	(1)
Marl, calcareous.....short tons..	(1)	(1)	(1)	(1)
Mica:				
Scrap.....do.....	2, 995	50, 505	4, 419	69, 638
Sheet.....pounds.....	665, 360	114, 514	777, 395	129, 706
Micaceous minerals (biotite and muscovite schist).....short tons..	(1)	(1)	(1)	(1)
Millstones.....		(1)		(1)
Mineral waters.....gallons sold..	(4)	(4)	(4)	(4)
Ores (crude):				
Copper.....short tons.....	38, 400	(5)	73, 330	(5)
Dry and siliceous (gold and silver).....do.....			70	(5)
Sand and gravel.....do.....	1, 462, 808	871, 416	971, 746	531, 092
Silica (quartz).....do.....	3, 396	19, 853	4, 113	40, 128
Silver.....troy ounces.....	5	3	19, 051	11, 145
Stone.....short tons.....	⁶ 2, 250, 870	⁶ 4, 913, 177	2, 126, 560	4, 690, 949
Talc.....do.....	(1)	(1)	(1)	(1)
Miscellaneous ⁷ do.....		6, 242, 623		10, 416, 425
Total value, eliminating duplications.....		11, 703, 671		11, 480, 406

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Exclusive of marble, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "1" and "6" above.*Mineral production of North Dakota in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		¹ \$130, 733		¹ \$167, 121
Clay, raw.....short tons.....	18	² 315	44	² 432
Coal.....do.....	1, 527, 939	2, 604, 000	1, 649, 930	2, 780, 000
Mineral waters.....gallons sold..	(3)	(3)	(3)	(3)
Natural gas.....M cubic feet.....	200	100	(4)	(4)
Sand and gravel.....short tons.....	343, 820	134, 830	624, 700	135, 200
Miscellaneous.....				300
Total value, eliminating duplications.....		2, 869, 663		3, 082, 621

¹ Figures obtained through cooperation with Bureau of the Census.² Value not included in total value for State.³ No canvass.⁴ Value included under "Miscellaneous."

Mineral production of Ohio in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Bromine.....pounds.....	(1)	(1)	(1)	(1)
Calcium chloride.....short tons.....	(1)	(1)	(1)	(1)
Cement.....barrels.....	² 8,727,879	² \$14,242,901	² 9,364,338	² \$14,928,183
Clay products.....		³ 92,595,130		³ 81,848,422
Clay, raw.....short tons.....	325,135	⁴ 799,932	303,685	⁴ 752,307
Coal.....do.....	15,799,697	30,376,000	15,641,225	26,439,000
Coke.....do.....	⁵ 7,213,619	⁴ 34,684,465	⁵ 7,786,199	⁴ 33,908,863
Ferro-alloys.....long tons.....	99,636	⁴ 3,178,165	87,221	⁴ 3,652,022
Grindstones and pulpstones.....short tons.....	23,501	881,537	23,877	790,203
Gypsum.....do.....	474,320	5,041,879	413,948	3,805,795
Iron, pig.....long tons.....	8,184,066	⁴ 150,125,790	9,266,936	⁴ 156,883,186
Lime.....short tons.....	987,726	9,497,324	1,013,676	8,919,596
Marl, calcareous.....do.....	(1)	(1)	(1)	(1)
Mineral paints, zinc and lead pigments.....do.....	(1 ⁴)	(1 ⁴)	(1 ⁴)	(1 ⁴)
Mineral waters.....gallons sold.....	(6)	(6)	(6)	(6)
Natural gas.....M cubic feet.....	51,381,000	28,881,000	56,341,000	32,090,000
Natural gasoline.....gallons.....	12,167,000	1,062,000	13,174,000	1,146,000
Petroleum.....barrels.....	7,593,000	14,970,000	7,015,000	14,470,000
Rubbing stones, scythestones, and whetstones.....short tons.....	319	49,495	296	45,299
Salt.....do.....	1,203,170	3,130,236	1,308,110	2,988,862
Sand and gravel.....do.....	13,187,415	9,085,413	14,286,169	9,116,356
Sand and sandstone (finely ground).....do.....	16,220	154,344	(1)	(1)
Sand-lime brick.....thousands.....	(1 ³)	(1 ³)	(1 ³)	(1 ³)
Stone.....short tons.....	⁷ 15,631,240	⁷ 16,769,636	13,717,410	14,195,607
Sulphuric acid ⁸ do.....	(1 ⁴)	(1 ⁴)	(1 ⁴)	(1 ⁴)
Miscellaneous ⁹		5,087,536		4,884,661
Total value, eliminating duplications.....		226,962,529		211,041,279

¹ Value included under "Miscellaneous."² Exclusive of natural cement, value for which is included under "Miscellaneous."³ Figures obtained through cooperation with Bureau of the Census.⁴ Value not included in total value for State.⁵ Exclusive of beehive coke, value for which is included under "Miscellaneous," but not in total value for State.⁶ No canvass.⁷ Exclusive of unclassified stone, value for which is included under "Miscellaneous."⁸ From zinc smelting.⁹ Includes minerals indicated by "1," "2," "3," and "7" above.

Mineral production of Oklahoma in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Asphalt (native).....short tons.....	(1)	(1)	(1)	(1)
Calcium chloride.....do.....	(1)	(1)	(1)	(1)
Cement.....barrels.....	(1)	(1)	(1)	(1)
Chats.....short tons.....	388,000	\$69,000	264,000	\$40,000
Clay products.....		² 1,693,669		² 1,726,369
Coal.....short tons.....	3,818,054	11,570,000	3,501,325	10,365,000
Gypsum.....do.....	271,484	2,073,944	397,752	2,021,635
Lead.....do.....	51,680	6,511,680	43,687	5,067,692
Lime.....do.....	(1)	(1)		
Mineral waters.....gallons sold.....	(3)	(3)	(3)	(3)
Natural gas.....M cubic feet.....	326,864,000	41,391,000	320,861,000	47,476,000
Natural gasoline.....gallons.....	548,109,000	29,114,000	619,691,000	40,959,000
Ores (crude), etc.:				
Lead.....short tons.....	1,000	(4)	50,000	(4)
Lead-zinc.....do.....	6,986,300	(4)	5,463,500	(4)
Zinc.....do.....	2,945,100	(4)	2,514,500	(4)
Petroleum.....barrels.....	277,775,000	397,200,000	249,857,000	347,600,000
Salt.....short tons.....	(1)	(1)	5,500	49,850
Sand and gravel.....do.....	2,074,963	1,331,222	2,827,810	1,426,258
Stone.....do.....	³ 1,720,050	³ 1,514,538	³ 1,986,890	³ 1,743,588
Sulphuric acid ⁶ do.....			(1 ⁷)	(1 ⁷)
Tripoli.....do.....	7,872	124,069	(1)	(1)
Zinc.....do.....	206,611	26,446,208	180,252	21,990,744
Miscellaneous ³		5,555,402		6,454,240
Total value, eliminating duplications.....		524,594,732		486,634,347

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ No canvass.⁴ Not valued as ore; value of recoverable metal content included under the metals.⁵ Exclusive of sandstone, value for which is included under "Miscellaneous."⁶ From zinc smelting.⁷ Value not included in total value for State.⁸ Includes minerals indicated by "1" and "4" above.*Mineral production of Oregon in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Briquets, fuel.....short tons.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Cement.....barrels.....	(1)		(1)	(1)
Clay products.....		³ \$656,563		³ \$450,205
Clay, raw.....short tons.....	2,570	² 2,834	(1 ²)	(1 ²)
Coal.....do.....	(1)	(1)	(1)	(1)
Copper.....pounds.....	488,200	63,954	358,463	51,619
Diatomite.....short tons.....	(1)	(1)	(1)	(1)
Gems and precious stones.....		(3)		(3)
Gold.....troy ounces.....	14,676	303,383	10,931	225,968
Lead.....short tons.....	3	334	7	768
Lime.....do.....	1,105	21,350	2,090	34,372
Mercury.....flasks.....	2,082	242,761	3,759	458,147
Mineral waters.....gallons sold.....	(3)	(3)	(3)	(3)
Ores (crude), etc.:				
Copper.....short tons.....	16,214	(3)	4,577	(3)
Dry and siliceous (gold and silver).....do.....	10,625	(3)	8,084	(3)
Lead.....do.....			15	(3)
Platinum and allied metals.....troy ounces.....	25	2,432	47	6,001
Sand and gravel.....short tons.....	2,415,069	1,438,798	2,441,945	1,453,070
Silver.....troy ounces.....	45,830	25,986	30,924	18,091
Stone.....short tons.....	1,863,830	1,951,631	1,875,250	2,117,322
Miscellaneous ⁷		2,912,900		2,589,411
Total value, eliminating duplications.....		6,821,224		6,686,988

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metals.⁷ Includes minerals indicated by "1" and "4" above.

Mineral production of Pennsylvania in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Briquets, fuel.....short tons..	152, 913	¹ \$997, 302	171, 357	¹ \$1, 093, 287
Cement.....barrels.....	² 42, 909, 513	² 66, 711, 069	² 41, 161, 019	² 62, 572, 588
Clay products.....		³ 50, 988, 821		³ 47, 928, 803
Clay, raw.....short tons.....	897, 798	¹ 2, 403, 428	971, 148	¹ 2, 532, 105
Coal:				
Anthracite.....do.....	80, 095, 564	420, 941, 726	75, 348, 069	393, 637, 690
Bituminous.....do.....	132, 964, 639	272, 714, 000	131, 202, 163	249, 895, 000
Coke.....do.....	16, 777, 291	¹ 67, 170, 075	16, 917, 355	¹ 62, 647, 772
Copper.....pounds.....	1, 735, 800	227, 390	4, 977, 885	716, 815
Feldspar (crude).....long tons.....	3, 938	24, 257	2, 052	8, 851
Ferro-alloys.....do.....	344, 032	¹ 32, 137, 339	384, 203	¹ 35, 129, 555
Gems and precious stones.....		(⁶)		(⁶)
Gold.....troy ounces.....	300	6, 201	992	20, 506
Iron ore:				
Sold to furnaces.....long tons.....	1, 124, 883	2, 559, 916	1, 013, 791	2, 411, 114
Sold for paint.....do.....	(⁶)	(⁶)	1, 790	(⁶)
Iron, pig.....do.....	11, 145, 334	¹ 212, 179, 275	12, 289, 455	¹ 216, 425, 084
Lime.....short tons.....	813, 571	6, 105, 241	834, 050	6, 119, 036
Mineral paints, zinc and lead pigments.....do.....	(¹ ⁶)	(¹ ⁶)	(¹ ⁶)	(¹ ⁶)
Mineral waters.....gallons sold.....	(⁶)	(⁶)	(⁶)	(⁶)
Natural gas.....M cubic feet.....	105, 709, 500	49, 135, 000	99, 466, 000	48, 432, 000
Natural gasoline.....gallons.....	16, 744, 000	1, 648, 000	16, 571, 000	1, 570, 000
Peat.....short tons.....	(⁶)	(⁶)	(⁶)	(⁶)
Petroleum.....barrels.....	9, 526, 000	29, 150, 000	9, 956, 000	32, 550, 000
Potassium salts.....short tons.....	(⁶)	(⁶)	(⁶)	(⁶)
Sand and gravel.....do.....	13, 832, 181	12, 040, 406	12, 955, 790	11, 289, 826
Sand and sandstone (finely ground).....do.....	(⁶)	(⁶)	(⁶)	(⁶)
Sand-lime brick.....thousands.....	(³ ⁶)	(³ ⁶)	(³ ⁶)	(³ ⁶)
Silica (quartz).....short tons.....	(⁶)	(⁶)	(⁶)	(⁶)
Silver.....troy ounces.....	2, 000	1, 134	7, 905	4, 624
Slate.....do.....		4, 769, 432		4, 786, 355
Stone.....short tons.....	16, 015, 480	18, 999, 592	16, 546, 850	18, 871, 736
Sulphuric acid (60° Baumé).....do.....	159, 112	¹ 1, 553, 000	128, 802	¹ 1, 273, 852
Talc.....do.....	(⁶)	(⁶)	(⁶)	(⁶)
Tripoli (rottenstone).....do.....	(⁶)	(⁶)	(⁶)	(⁶)
Miscellaneous.....do.....		13, 517, 594		13, 079, 109
Total value, eliminating duplications.....		936, 773, 189		881, 490, 033

¹ Value not included in total value for State.² Exclusive of natural cement, value for which is included under "Miscellaneous."³ Figures obtained through cooperation with Bureau of the Census.⁴ Copper, gold, and silver were recovered from pyritiferous magnetite. The quantity of such ore was 1,132,010 short tons in 1927 and 1,083,140 short tons in 1928; it is included in the figures shown for iron ore.⁵ No canvass.⁶ Value included under "Miscellaneous."⁷ From zinc smelting.⁸ Includes minerals indicated by "²" and "⁶" above.*Mineral production of Rhode Island in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		(¹ ²)		
Coke.....short tons.....	(¹ ³)	(¹ ³)	(¹ ³)	(¹ ³)
Graphite, amorphous.....do.....	(¹)	(¹)	(¹)	(¹)
Lime.....do.....	2, 937	\$43, 342	2, 589	\$36, 875
Mineral waters.....gallons sold.....	(⁴)	(⁴)	(⁴)	(⁴)
Sand and gravel.....short tons.....	271, 065	303, 639	192, 862	56, 610
Stone.....do.....	⁵ 153, 400	⁵ 734, 164	149, 130	707, 257
Miscellaneous.....do.....		1, 360, 219		1, 164, 332
Total value, eliminating duplications.....		1, 310, 756		830, 742

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Value not included in total value for State.⁴ No canvass.⁵ Exclusive of limestone, value for which is included under "Miscellaneous."⁶ Includes minerals indicated by "¹" and "⁶" above.

Mineral production of South Carolina in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Barite.....short tons..	(1)	(1)	(1)	(1)
Clay products.....		^{2 3} \$1,802,772		² \$1,462,055
Clay, raw.....short tons..	81,010	⁴ 743,742	109,186	⁴ 1,000,103
Gold.....troy ounces..			10	197
Marl, calcareous.....short tons..	(1)	(1)	(1)	(1)
Mineral waters.....gallons sold..	(5)	(5)	(5)	(5)
Sand and gravel.....short tons..	893,772	397,781	507,716	341,391
Silver.....troy ounces..			1	1
Stone.....short tons..	1,197,870	1,992,558	1,278,190	2,203,863
Miscellaneous ⁶		58,026		38,342
Total value, eliminating duplications.....		4,251,137		4,045,849

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁵ No canvass.⁶ Includes minerals indicated by "1" and "3" above.*Mineral production of South Dakota in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Cement.....barrels..	(1)	(1)	(1)	(1)
Clay, raw.....short tons..	1,056	² \$4,194	1,066	² \$10,660
Coal.....do.....	12,507	38,000	13,929	39,000
Columbite.....pounds..	1,100	378	34,899	26,332
Feldspar (crude).....long tons..	(1)	(1)	(1)	(1)
Flint lining for tube mills.....short tons..	(1)	(1)		
Gems and precious stones.....		(3)		(3)
Gold.....troy ounces..	322,032	6,656,987	317,379	6,560,805
Gypsum.....short tons..	(1)	(1)	(1)	(1)
Lead.....do.....69		8,694	37	4,292
Lime.....do.....	(1)	(1)	(1)	(1)
Lithium minerals.....do.....	(1)	(1)	(1)	(1)
Mica, scrap.....do.....	(1)	(1)	(1)	(1)
Mineral waters.....gallons sold..	(3)	(3)	(3)	(3)
Natural gas.....M cubic feet..	92,000	136,500	54,000	53,000
Ores (crude), etc.:.....				
Dry and siliceous (gold and silver).....short tons..	1,376,583	(4)	1,422,138	(4)
Lead.....do.....			95	(4)
Sand and gravel.....do.....	1,162,823	231,218	2,461,963	1,301,075
Sand-lime brick.....thousands..	(1 s)	(1 s)	(1 s)	(1 s)
Silver.....troy ounces..	96,171	54,529	90,547	52,970
Stone.....short tons..	264,500	535,232	172,360	451,869
Tin (metallic equivalent).....do.....	(6)	200	2	2,000
Tungsten ore (60 per cent concentrates).....do.....	141	(1)	(1)	(1)
Miscellaneous ⁷		802,214		952,145
Total value, eliminating duplications.....		8,463,952		9,443,488

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ No canvass.⁴ Not valued as ore; value of recoverable metal content included under the metals.⁵ Figures obtained through cooperation with Bureau of the Census.⁶ 325 pounds.⁷ Includes minerals indicated by "1" above.

Mineral production of Tennessee in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Aluminum.....pounds.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Barite.....short tons.....	20, 537	\$129, 999	20, 260	\$150, 937
Bauxite.....long tons.....			460	(1)
Cement.....barrels.....	4, 343, 337	6, 580, 732	4, 634, 280	6, 322, 213
Clay products.....		³ 3, 728, 380		³ 4, 030, 251
Clay, raw.....short tons.....	149, 629	² 661, 813	123, 587	² 613, 554
Coal.....do.....	5, 783, 367	10, 645, 000	5, 610, 959	9, 694, 000
Coke.....do.....	227, 120	² 1, 149, 604	216, 925	² 1, 063, 887
Copper.....pounds.....	14, 940, 595	1, 957, 217	16, 374, 261	2, 357, 894
Ferro-alloys.....long tons.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Gold.....troy ounces.....	426	8, 816	538	11, 117
Iron ore:				
Sold to furnaces.....long tons.....	121, 220	274, 620	128, 478	286, 524
Sold for paint.....do.....	(1)	(1)	(1)	(1)
Iron, pig.....do.....	87, 971	³ 1, 911, 380	102, 718	² 1, 920, 901
Iron sinter from copper sulphide ore.....do.....	45, 983	(1)	85, 496	(1)
Lime.....short tons.....	181, 385	1, 266, 326	183, 541	1, 238, 945
Manganese ore.....long tons.....	498	8, 182	55	(1)
Manganiferous ore.....do.....	487	3, 442	763	(1)
Mineral waters.....gallons sold.....	(⁶)	(⁶)	(⁶)	(⁶)
Natural gas.....M cubic feet.....	9, 000	2, 200	(1)	(1)
Ores (crude), etc.:				
Copper.....short tons.....	630, 955	(⁶)	759, 995	(⁶)
Zinc.....do.....	521, 200	(⁶)	570, 199	(⁶)
Petroleum.....barrels.....	60, 000	90, 000	46, 000	70, 000
Phosphate rock.....long tons.....	481, 769	2, 318, 785	577, 095	2, 856, 850
Sand and gravel.....short tons.....	2, 479, 249	1, 842, 144	2, 939, 541	2, 157, 515
Silver.....troy ounces.....	81, 460	46, 188	75, 558	44, 201
Slate.....		(1)		(1)
Stone.....short tons.....	2, 145, 390	6, 430, 631	⁷ 2, 335, 530	⁷ 7, 288, 666
Sulphuric acid ⁸ do.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Tripoli.....do.....	(1)	(1)	(1)	(1)
Zinc.....do.....	10, 400	1, 331, 200	(1)	(1)
Miscellaneous ⁹		10, 406, 824		16, 174, 805
Total value, eliminating duplications.....		37, 874, 981		38, 789, 242

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metals.⁷ Exclusive of sandstone, value for which is included under "Miscellaneous."⁸ From copper smelting.⁹ Includes minerals indicated by "1," "4," and "7" above.

Mineral production of Texas in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Asphalt (native).....short tons..	376, 770	\$1, 254, 500	321, 505	\$815, 482
Cement.....barrels..	5, 692, 350	10, 232, 908	6, 231, 083	10, 938, 646
Clay products.....		¹ 6, 417, 017		¹ 6, 176, 802
Clay, raw.....short tons..	3, 193	² 19, 063	3, 158	² 18, 831
Coal.....do..	1, 326, 385	1, 998, 000	1, 182, 034	1, 589, 000
Copper.....pounds..	21, 458	2, 811	447, 792	64, 482
Fuller's earth.....short tons..	26, 938	283, 400	33, 388	338, 080
Gems and precious stones.....		(³)		(³)
Gold.....troy ounces..	396	8, 192	489	10, 115
Graphite, crystalline.....pounds..	(⁴)	(⁴)	(⁴)	(⁴)
Gypsum.....short tons..	508, 382	4, 003, 456	509, 472	3, 094, 145
Lead.....do..	244	30, 743	348	40, 343
Lime.....do..	80, 796	733, 678	82, 325	751, 729
Marl, greensand.....do..	(⁴)	(⁴)	(⁴)	(⁴)
Mercury.....flasks..	(⁴)	(⁴)	(⁴)	(⁴)
Mineral waters.....gallons sold..	(⁵)	(⁵)	(⁵)	(⁵)
Natural gas.....M cubic feet..	254, 063, 000	37, 424, 800	301, 990, 000	51, 316, 000
Natural gasoline.....gallons..	320, 723, 000	18, 347, 000	324, 516, 000	22, 492, 000
Ores (crude), etc.:				
Copper.....short tons..			4, 494	(⁶)
Dry and siliceous (gold and silver).....do..	50, 719	(⁶)	72, 364	(⁶)
Lead.....do..	40	(⁶)	57	(⁶)
Petroleum.....barrels..	217, 389, 000	248, 550, 000	257, 320, 000	236, 300, 000
Salt.....short tons..	54, 270	399, 171	(⁴)	(⁴)
Sand and gravel.....do..	9, 695, 152	4, 694, 134	8, 007, 392	4, 602, 421
Sand-lime brick.....thousands..	(¹ ⁴)	(¹ ⁴)	(¹ ⁴)	(¹ ⁴)
Silver.....troy ounces..	1, 034, 866	586, 769	1, 340, 622	784, 264
Stone.....short tons..	3, 267, 940	2, 534, 866	3, 130, 050	2, 522, 495
Sulphur.....long tons..	(⁴)	(⁴)	(⁴)	(⁴)
Miscellaneous ⁶		37, 001, 975		36, 780, 951
Total value, eliminating duplications.....		374, 503, 420		378, 616, 955

¹ Figures obtained through cooperation with Bureau of the Census.² Value not included in total value for State.³ No canvass.⁴ Value included under "Miscellaneous."⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Includes minerals indicated by "⁴" above.

Mineral production of Utah in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Arsenious oxide.....short tons..	4, 231	\$327, 956	2, 674	\$170, 711
Asphalt (native).....do.....	42, 940	933, 570	57, 447	1, 195, 451
Bismuth.....pounds.....	(1)	(1)	(1)	(1)
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		² 1, 024, 559		² 444, 536
Clay, raw.....short tons.....	17, 313	⁴ 108, 380	24, 897	⁴ 156, 951
Coal.....do.....	4, 781, 480	11, 084, 000	4, 842, 544	12, 253, 000
Coke.....do.....	282, 048	(1)	274, 600	(1)
Copper.....pounds.....	256, 933, 278	33, 658, 259	293, 235, 039	42, 225, 846
Diatomite.....short tons.....	35	700		
Gems and precious stones.....		(6)		(6)
Gold.....troy ounces.....	193, 909	4, 008, 451	212, 560	4, 394, 001
Gypsum.....short tons.....	(1)	(1)	28, 103	136, 766
Iron ore.....long tons.....	222, 879	(1)	320, 655	(1)
Iron, pig.....do.....	(1)	(1)	164, 071	(1)
Lead.....short tons.....	151, 285	19, 061, 913	145, 915	16, 926, 141
Lime.....do.....	48, 882	397, 088	47, 662	385, 476
Manganese ore.....long tons.....	27	(1)		
Manganiferous ore.....do.....	239	(1)	286	(1)
Marl, calcareous.....short tons.....	(1)	(1)	(1)	(1)
Natural gas.....M cubic feet.....	(1)	(1)	1, 105, 000	22, 000
Ores (crude), etc.:.....				
Copper.....short tons.....	13, 879, 173	(6)	16, 631, 757	(6)
Copper-lead.....do.....	73, 878	(6)	45, 365	(6)
Dry and siliceous (gold and silver).....do.....	245, 344	(6)	211, 758	(6)
Lead.....do.....	337, 734	(6)	341, 194	(6)
Lead-zinc.....do.....	1, 220, 945	(6)	1, 197, 043	(6)
Petroleum.....barrels.....	(1)	(1)	(1)	(1)
Salt.....short tons.....	74, 690	334, 732	85, 800	193, 582
Sand and gravel.....do.....	903, 244	272, 609	1, 000, 131	544, 020
Sand-lime brick.....thousands.....	(1)	(1)	(1)	(1)
Silver.....troy ounces.....	18, 606, 950	10, 550, 141	17, 072, 852	9, 987, 618
Stone.....short tons.....	⁷ 739, 830	⁷ 561, 932	881, 730	818, 415
Sulphur.....long tons.....	(1)	(1)	(1)	(1)
Uranium and vanadium ores.....short tons.....	(1)	(1)	(1)	(1)
Zinc.....do.....	49, 593	6, 347, 868	46, 929	5, 725, 298
Miscellaneous ⁸ do.....		6, 364, 481		6, 916, 793
Total value, eliminating duplications.....		90, 388, 455		97, 381, 148

¹ Value included under "Miscellaneous."² Figures obtained through cooperation with Bureau of the Census.³ Exclusive of pottery, value for which is included under "Miscellaneous."⁴ Value not included in total value for State.⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metals.⁷ Exclusive of marble, value for which is included under "Miscellaneous."⁸ Includes minerals indicated by "1," "3," and "7" above.*Mineral production of Vermont in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		(1)		(1)
Clay, raw.....short tons.....	(2)	(2)	(1)	(2)
Copper.....pounds.....	208, 224	\$27, 278		
Lime.....short tons.....	61, 024	683, 440	52, 445	\$485, 235
Mineral waters.....gallons sold.....	(1)	(1)	(1)	(1)
Ore (copper).....short tons.....	4, 363	(6)		
Sand and gravel.....do.....	171, 250	39, 143	295, 524	108, 461
Scythstones.....troy ounces.....	(2)	(2)	(2)	(2)
Silver.....	821	465		
Slate.....		4, 108, 911		3, 981, 028
Stone.....short tons.....	321, 970	9, 216, 116	⁶ 448, 060	⁶ 9, 438, 796
Talc.....do.....	54, 688	503, 716	52, 125	502, 501
Miscellaneous ⁷ do.....		136, 872		141, 538
Total value, eliminating duplications.....		14, 702, 891		14, 648, 737

¹ Figures obtained through cooperation with Bureau of the Census.² Value included under "Miscellaneous."³ Value not included in total value for State.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Exclusive of unclassified stone, value for which is included under "Miscellaneous."⁷ Includes minerals indicated by "3" and "6" above.

Mineral production of Virginia in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Barite.....short tons..	(1)	(1)	(1)	(1)
Briquets, fuel.....do....	(1 ²)	(1 ²)	23, 134	² \$139, 252
Cement.....barrels..	(1)	(1)	(1)	(1)
Clay products.....		³ \$2, 932, 998		³ \$2, 940, 832
Clay, raw.....short tons..	25, 497	² 211, 869	9, 970	² 71, 147
Coal.....do....	12, 916, 042	23, 203, 000	11, 900, 933	20, 375, 000
Coke.....do....	316, 754	² 1, 413, 595	247, 734	² 1, 052, 016
Emery.....do....	(1)	(1)	573	8, 595
Feldspar (crude).....long tons..	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Ferro-alloys.....do....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Gem feldspar.....pounds..	2, 500	2, 500	12, 000	12, 000
Gypsum.....short tons..	(1)	(1)	(1)	(1)
Iron ore.....long tons..	66, 897	172, 877	27, 970	83, 114
Iron, pig.....do....	84, 920	² 1, 782, 538	63, 175	² 1, 245, 809
Lead.....short tons..	2, 393	300, 518	(1)	(1)
Lime.....do....	178, 426	1, 317, 581	174, 067	1, 208, 618
Manganese ore.....long tons..	3, 212	76, 222	3, 812	(1)
Manganiferous ore.....do....	1, 206	8, 000	105	(1)
Marl, calcareous.....short tons..	24, 225	77, 851	29, 818	95, 108
Mica:				
Scrap.....do....	(1)	(1)	(1)	(1)
Sheet.....pounds..	(1)	(1)	(1)	(1)
Millstones.....		(1)		(1)
Mineral waters.....gallons sold..	(9)	(9)	(9)	(9)
Ores (crude), etc.:				
Lead-zinc.....short tons..	201, 679	(9)	(9)	(9)
Pyrites.....long tons..	(1)	(1)	(1)	(1)
Salt.....short tons..	(1)	(1)	(1)	(1)
Sand and gravel.....do....	1, 502, 248	1, 217, 450	1, 602, 444	1, 081, 948
Sand and sandstone (finely ground).....do....	(1)	(1)	(1)	(1)
Silica (quartz).....do....	(1)	(1)		
Slate.....		⁸ 398, 612		⁸ 458, 153
Stone.....short tons..	⁹ 3, 140, 170	⁹ 3, 320, 385	⁹ 3, 289, 350	⁹ 3, 358, 104
Talc and soapstone.....do....	(1)	(1)	(1)	(1)
Titanium minerals:				
Ilmenite.....do....	(1)	(1)	(1)	(1)
Rutile.....do....	(1)	(1)	(1)	(1)
Zinc.....do....	8, 325	1, 065, 600	(1)	(1)
Miscellaneous ¹⁰ do....		8, 530, 620		11, 269, 940
Total value, eliminating duplications.....		41, 322, 998		38, 770, 281

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metals.⁷ Bureau of Mines not at liberty to publish figures.⁸ Exclusive of granules, etc., value for which is included under "Miscellaneous."⁹ Exclusive of marble in 1927 and of basalt in 1928, value for which is included under "Miscellaneous."¹⁰ Includes mineral indicated by "1," "4," "8," and "9" above.

Mineral production of Washington in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Briquets, fuel.....short tons.....	(1 ²)	(1 ²)	63, 221	² \$412, 603
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		² \$2, 518, 250		² 1, 968, 926
Clay, raw.....short tons.....	31, 463	² 40, 428	35, 041	² 39, 632
Coal.....do.....	2, 635, 062	9, 222, 000	2, 519, 901	8, 720, 000
Coke.....do.....	71, 271	² 530, 759	59, 502	² 437, 187
Copper.....pounds.....	1, 685, 848	220, 846	1, 177, 246	169, 523
Diatomite.....short tons.....	760	13, 900	804	12, 705
Gold.....troy ounces.....	19, 514	403, 380	16, 310	337, 167
Iron ore.....long tons.....	550	(1)	1, 012	(1)
Lead.....short tons.....	478	60, 165	542	62, 915
Lime.....do.....	23, 959	382, 294	24, 529	265, 922
Magnesite.....do.....	77, 740	583, 050	85, 900	644, 250
Mercury.....flasks.....	566	65, 996	(1)	(1)
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Ores (crude), etc.:.....				
Copper.....short tons.....	37, 564	(5)	28, 560	(5)
Copper-lead.....do.....			700	(5)
Dry and siliceous (gold and silver).....do.....	43, 450	(5)	33, 956	(5)
Lead.....do.....	1, 648	(5)	887	(5)
Lead-zinc.....do.....	1, 232	(5)	101	(5)
Zinc.....do.....	35, 307	(5)	350	(5)
Pulpstones.....do.....	(1)	(1)	(1)	(1)
Rubbing stones.....do.....	(1)	(1)	(1)	(1)
Sand and gravel.....do.....	4, 423, 246	1, 570, 999	5, 917, 748	2, 001, 195
Silica (quartz).....do.....	273	2, 070	(1)	(1)
Silver.....troy ounces.....	155, 850	88, 367	99, 738	58, 347
Sodium sulphate from natural sources.....short tons.....	(1)	(1)		
Stone.....do.....	975, 850	958, 841	1, 037, 160	1, 325, 768
Zinc.....do.....	640	81, 901	43	5, 204
Miscellaneous ⁶		6, 363, 918		6, 547, 619
Total value, eliminating duplications.....		21, 965, 917		22, 119, 541

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Includes minerals indicated by "1" above.*Mineral production of West Virginia in 1927 and 1928*

Product	1927		1928	
	Quantity	Value	Quantity	Value
Briquets, fuel.....short tons.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Bromine.....pounds.....	(1)	(1)	58, 400	\$15, 238
Calcium chloride.....short tons.....	3, 455	\$33, 550	1, 760	19, 112
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		³ 16, 320, 373		³ 19, 027, 545
Clay, raw.....short tons.....	48, 332	² 85, 304	41, 836	² 66, 621
Coal.....do.....	145, 122, 447	249, 730, 000	132, 952, 159	211, 480, 000
Coke.....do.....	1, 923, 427	² 6, 840, 358	1, 798, 900	² 5, 305, 393
Ferro-alloys.....long tons.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Grindstones and pulpstones.....short tons.....	7, 113	616, 177	8, 857	682, 634
Iron, pig.....long tons.....	504, 816	(1 ²)	645, 038	(1 ²)
Lime.....short tons.....	244, 950	1, 643, 109	279, 947	1, 788, 989
Marl, calcareous.....do.....	(1)	(1)	(1)	(1)
Mineral waters.....gallons sold.....	(4)	(4)	(4)	(4)
Natural gas.....M cubic feet.....	162, 375, 000	67, 994, 000	163, 018, 000	72, 265, 000
Natural gasoline.....gallons.....	64, 192, 000	5, 421, 000	69, 729, 000	6, 220, 000
Petroleum.....barrels.....	6, 023, 000	17, 410, 000	5, 661, 000	17, 150, 000
Salt.....short tons.....	22, 600	167, 155	18, 700	149, 421
Sand and gravel.....do.....	2, 522, 617	2, 879, 631	2, 383, 659	2, 773, 341
Sand and sandstone (finely ground).....do.....	(1)	(1)	(1)	(1)
Stone.....do.....	3, 171, 120	2, 962, 922	³ 3, 143, 780	² 2, 908, 657
Sulphuric acid ⁶ do.....	(1 ²)	(1 ²)	(1 ²)	(1 ²)
Miscellaneous ⁷		11, 108, 845		13, 971, 405
Total value, eliminating duplications.....		366, 643, 205		336, 636, 948

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ No canvass.⁵ Exclusive of unclassified stone, value for which is included under "Miscellaneous."⁶ From zinc smelting.⁷ Includes minerals indicated by "1" and "4" above.

Mineral production of Wisconsin in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Barite.....short tons..	(1)	(1)	(1)	(1)
Briquets, fuel.....do....	(1 2)	(1 2)	586, 611	¹ \$4, 904, 443
Cement.....barrels.....	(1)	(1)	(1)	(1)
Clay products.....		³ ⁴ \$1, 228, 338		³ ⁴ 1, 007, 826
Clay, raw.....short tons..	(1 2)	(1 2)	508	² 983
Coke.....do.....	(1 2)	(1 2)	(1 2)	(1 2)
Iron ore:				
Sold to furnaces.....long tons..	937, 935	2, 567, 078	1, 394, 371	3, 700, 797
Sold for paint.....do.....	2, 415	7, 136	2, 292	(1)
Iron, pig.....do.....	(1 2)	(1 2)	(1 2)	(1 2)
Lead.....short tons.....	2, 069	260, 694	1, 698	196, 968
Lime.....do.....	197, 667	1, 733, 009	163, 965	1, 374, 749
Manganiferous ore.....long tons..	284, 470	818, 604		
Marl, calcareous.....short tons..	310	2, 170		
Mineral paints, zinc and lead pigments				
.....short tons.....	(1 2)	(1 2)	(1 2)	(1 2)
Mineral waters.....gallons sold..	(5)	(5)	(5)	(5)
Ores (crude), etc.:				
Lead.....short tons.....	1, 000	(6)		
Lead-zinc.....do.....	562, 700	(6)	627, 300	(6)
Zinc.....do.....	917, 100	(6)	106, 200	(6)
Sand and gravel.....do.....	9, 020, 124	3, 190, 334	10, 104, 015	3, 680, 420
Sand-lime brick.....thousands..	(1 3)	(1 3)	(1 3)	(1 3)
Silica (quartz).....short tons.....	(1)	(1)	(1)	(1)
Stone.....do.....	⁷ 3, 104, 240	⁷ 5, 181, 631	3, 313, 740	5, 516, 017
Sulphuric acid ⁸ do.....	(1 2)	(1 2)	(1 2)	(1 2)
Zinc.....do.....	32, 841	4, 203, 648	18, 417	2, 246, 874
Miscellaneous ⁹		16, 331, 880		9, 434, 456
Total value, eliminating duplications.....		21, 776, 847		20, 889, 395

¹ Value included under "Miscellaneous."² Value not included in total value for State.³ Figures obtained through cooperation with Bureau of the Census.⁴ Exclusive of pottery, value for which is included under "Miscellaneous."⁵ No canvass.⁶ Not valued as ore; value of recoverable metal content included under the metals.⁷ Exclusive of basalt, value for which is included under "Miscellaneous."⁸ From zinc smelting.⁹ Includes minerals indicated by "1," "4," and "7" above.

Mineral production of Wyoming in 1927 and 1928

Product	1927		1928	
	Quantity	Value	Quantity	Value
Clay products.....		¹ \$101,708		¹ \$103,426
Clay, raw..... short tons..	7,500	² 121,163	22,921	² 383,994
Coal..... do.....	6,753,656	18,152,000	6,571,683	17,363,000
Copper..... pounds.....			2,604	375
Gold..... troy ounces.....	58	1,200	33	677
Gypsum..... short tons.....	(³)	(³)	(³)	(³)
Iron ore..... long tons.....	602,877	(³)	491,280	(³)
Lime..... short tons.....	30	600		
Mineral waters..... gallons sold.....	(⁴)	(⁴)	(⁴)	(⁴)
Natural gas..... M cubic feet.....	43,581,600	3,269,800	47,490,000	3,527,000
Natural gasoline..... gallons.....	43,212,000	2,899,000	42,861,000	2,775,000
Ores (crude), etc.:				
Copper..... short tons.....			29	(⁵)
Dry and siliceous (gold and silver)..... short tons.....	110	(⁵)	100	(⁵)
Petroleum..... barrels.....	21,307,000	29,830,000	21,461,000	27,400,000
Phosphate rock..... long tons.....	6,250	29,000	3,388	14,399
Sand and gravel..... short tons.....	1,360,475	494,065	1,742,880	414,004
Shale oil..... gallons.....	(⁶)	(⁷)		
Silver..... troy ounces.....	5	3	53	31
Sodium sulphate from natural sources..... short tons.....	(³)	(³)	(³)	(³)
Stone.....	253,230	431,104	⁸ 280,180	⁸ 454,136
Miscellaneous ⁹ do.....		958,120		898,827
Total value, eliminating duplications.....		56,166,600		52,950,875

¹ Figures obtained through cooperation with Bureau of the Census.² Value not included in total value for State.³ Value included under "Miscellaneous."⁴ No canvass.⁵ Not valued as ore; value of recoverable metal content included under the metals.⁶ Bureau of Mines not at liberty to publish figures.⁷ No data available.⁸ Exclusive of unclassified stone, value for which is included under "Miscellaneous."Includes minerals indicated by "³" and "⁵" above.

PREFATORY NOTE TO THE REPORTS ON GOLD, SILVER, COPPER, LEAD, AND ZINC

By FRANK J. KATZ

Chief Engineer, Division of Mineral Statistics

In the mining industry, gold, silver, copper, lead, and zinc are closely related in both the genesis and the geologic occurrence of their ores, as well as in mining and in metallurgical treatment. Of their ores some contain all five metals, many contain three or four, and few contain only one. Gold and silver, for instance, almost everywhere show close genetic relations, and their ores are usually mined together. Lead and zinc constitute a similar pair. Copper ores almost invariably yield some silver and gold as well as copper, and most lead ores yield notable supplies of silver. Zinc ores in the Western States contribute also to the production of silver. All five metals may occur in commercial quantity in a single mine or, more commonly, in a single mining district. For these reasons each of these metals is treated in Mineral Resources in a general report, and all five metals are grouped together in "mine reports" descriptive of individual or geographically grouped States. These reports are printed in 15 pamphlets.

To facilitate advance publication each report is published separately at the earliest date possible. The general reports give figures of the output of the metals in the first marketable form, as obtained from the smelters, refineries, and mints, together with general reviews of the respective industries for the entire country. The figures given in the general reports represent the final official statistics of production for the country and of the States. The general report on gold and silver includes the statistics of recovered precious metals as determined by the Bureau of the Mint. The "mine reports" give figures of the production (called "mine production") as obtained from the mines, so far as possible in terms of both gross and recoverable metal in ores and other material sold or treated during the year; they also supply information in detail relative to the mining industry in the respective States, counties, and mining districts.

These reports, which appear as separate chapters in this volume, are as follows:

Gold and silver (general report).

Copper (general report).

Lead (general report).

Zinc (general report).

Silver, copper, lead, and zinc in the Central States (mine report).

Gold, silver, copper, lead, and zinc in the Eastern States (mine report).

Gold, silver, copper, lead, and zinc in Arizona (mine report).

Gold, silver, copper, lead, and zinc in California and Oregon (mine report).

Gold, silver, copper, lead, and zinc in Colorado (mine report).

Gold, silver, copper, lead, and zinc in Idaho and Washington (mine report).

Gold, silver, copper, lead, and zinc in Montana (mine report).

Gold, silver, copper, lead, and zinc in Nevada (mine report).

Gold, silver, copper, lead, and zinc in New Mexico and Texas (mine report).

Gold, silver, copper, and lead in South Dakota and Wyoming (mine report).

Gold, silver, copper, lead, and zinc in Utah (mine report).

In stating quantity of ores, concentrates, and similar material the short ton of 2,000 pounds is used throughout. The term "ore" as used here denotes any metalliferous material treated at the mine or shipped to reduction plants and paid for by those plants, whether or not it nets a profit to the miner. The ore classification is necessarily arbitrary, because of the varying factors affecting mining and treatment of ores. Dry and siliceous ores comprise gold and silver ores proper, as well as fluxing ores that carry considerable quantities of iron and manganese oxides and very small quantities of gold and silver and also gold and silver ores that carry copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The copper ores include the great disseminated copper deposits of the West, the copper ores of the Lake Superior region, and other ores in which copper is the most abundant base metal paid for. The lead and zinc ores are those in which lead or zinc is the only or chief base metal present, irrespective of their precious-metal content. The mixed ores are those whose commercial value depends on the recoverable or recovered contents of two or more base metals in addition to any precious metals they may contain. If one of the metals, though present in sufficient quantity, is not recovered, that metal is disregarded in naming the ore. An improvement in metallurgy may later serve to change the name of such ore. The classification based on methods of treatment is the only satisfactory commercial classification.

It is to be understood, of course, that market values are not received by producers for metals in ore and intermediate products nor always for metals in marketable form, that payment is made in accordance with contracts for treatment or sale, and therefore that average daily quotations do not necessarily agree with average prices received.

Prices of silver, copper, lead, and zinc, 1850-1928

Year	Silver ¹	Copper ²	Lead ³	Zinc ⁴	Year	Silver ¹	Copper ²	Lead ³	Zinc ⁴
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1850	\$1.32	\$0.22	\$0.05		1890	\$1.05	\$0.156	\$0.045	\$0.055
1851	1.34	.166	.05		1891	.99	.128	.043	.65
1852	1.33	.22	.05		1892	.87	.116	.041	.046
1853	1.35	.22	.06	\$0.055	1893	.78	.108	.037	.04
1854	1.35	.22	.06		1894	.63	.095	.033	.035
1855	1.34	.27	.07		1895	.65	.107	.032	.036
1856	1.34	.27	.066		1896	.68	.108	.03	.039
1857	1.35	.25	.06		1897	.60	.12	.036	.041
1858	1.34	.23	.06		1898	.59	.124	.038	.046
1859	1.36	.22	.055		1899	.60	.171	.045	.058
1860	1.35	.23	.056		1900	.62	.166	.044	.044
1861	1.33	.22	.05		1901	.60	.167	.043	.041
1862	1.35	.22	.06		1902	.53	.122	.041	.048
1863	1.345	.34	.06		1903	.54	.137	.042	.054
1864	1.345	.47	.07	.139	1904	.58	.128	.043	.051
1865	1.337	.392	.066		1905	.61	.156	.047	.059
1866	1.339	.342	.07		1906	.68	.193	.057	.061
1867	1.33	.254	.065		1907	.66	.20	.053	.059
1868	1.326	.23	.065		1908	.53	.132	.042	.047
1869	1.325	.242	.06		1909	.52	.13	.043	.054
1870	1.328	.212	.06		1910	.54	.127	.044	.054
1871	1.325	.241	.06		1911	.53	.125	.045	.057
1872	1.322	.356	.064		1912	.615	.165	.045	.069
1873	1.297	.280	.06		1913	.604	.155	.044	.056
1874	1.278	.220	.06		1914	.553	.133	.039	.051
1875	1.24	.227	.058	.07	1915	.507	.175	.047	.124
1876	1.16	.21	.061	.072	1916	.658	.246	.069	.134
1877	1.20	.19	.055	.06	1917	.824	.273	.086	.102
1878	1.15	.166	.036	.049	1918	1.00	.247	.071	.091
1879	1.12	.186	.041	.052	1919	1.12	.186	.053	.073
1880	1.15	.214	.05	.055	1920	1.09	.184	.08	.081
1881	1.13	.182	.048	.052	1921	1.00	.129	.045	.05
1882	1.14	.191	.049	.053	1922	1.00	.135	.055	.057
1883	1.11	.165	.043	.045	1923	.82	.147	.07	.068
1884	1.11	.13	.037	.044	1924	.67	.131	.08	.065
1885	1.07	.108	.040	.043	1925	.694	.142	.087	.076
1886	.99	.111	.046	.044	1926	.624	.14	.08	.075
1887	.98	.138	.045	.046	1927	.567	.131	.063	.064
1888	.94	.168	.044	.049	1928	.585	.144	.058	.061
1889	.94	.135	.039	.05					

¹ Report of Director of the Mint, pp. 212-213, 1914. Equivalent value of fine ounce based on average price and average rate of exchange. For 1916, 1917, and 1919, dealers' buying price, New York. For 1918, early estimate furnished by the Bureau of the Mint. For 1920 to 1922, New York market price for domestic silver only. For 1923, average price under Pittman Act, from Jan. 1 to June 2, for domestic silver; average New York price for all silver after that period. For 1924 and later years, average New York price for bar silver.

² Weed, W. H., Copper Handbook, vol. 11, pp. 1339, 1343, for years 1850-1903. By computation from data for years 1850-1860, p. 1339. U. S. Geological Survey computations for electrolytic copper since 1904. For 1916 and later years, average price all marketable grades.

³ New York price, Ingalls, W. R., Lead and Zinc in the United States, p. 203, 1908. U. S. Geological Survey since 1904. For 1916, outside spot quotations, New York. For 1917 and later years, average price all grades.

⁴ New York price, 1875-1904, Ingalls, W. R., Lead and Zinc in the United States, p. 342, 1908. St. Louis price, U. S. Geological Survey, since 1904. For 1915 and later years, average price all grades. Oral communication from C. E. Siebenthal, of the U. S. Geological Survey, for 1853 and 1864.

ARSENIC, BISMUTH, SELENIUM, AND TELLURIUM

By V. C. HEIKES ¹

ARSENIC

PRODUCTION AND SALES

Production of arsenic (arsenious oxide) in the United States in 1928 amounted to 14,163 short tons, of which 9,276 tons was refined and 4,887 tons was crude. Nearly all of the output was a by-product from smelting copper and lead ores; some was derived from arsenical gold ore. The products for the market consisted of refined white arsenic, crude white arsenic, "flue" dust, and "treater" dust.

No red arsenic sulphide or elemental arsenic was reported in 1928.

Of the refined and crude arsenic produced 11,767 tons was sold; it was valued at \$735,373, or 3.125 cents a pound. The refined white arsenic, 8,115 tons, was sold for \$537,950, or 3.315 cents a pound; the crude arsenic, 3,652 tons, was sold for \$197,423, or 2.703 cents a pound. Arsenic from all sources sold by producers in the United States during the past 10 years is shown in the following table.

Crude and refined white arsenic sold by producers in the United States, 1919-1928

Year	Short tons		Value		Year	Short tons		Value	
	Refined	Crude	Total	Average (cents per pound)		Refined	Crude	Total	Average (cents per pound)
1919.....	6,029		\$1,181,684	9.8	1924.....	12,270	2,183	\$2,655,015	9.2
1920.....	10,942	560	2,021,356	8.8	1925.....	11,240	1,077	1,199,247	4.9
1921.....	3,427	1,359	717,700	7.5	1926.....	10,977	828	674,350	2.9
1922.....	8,905	1,122	1,475,229	7.4	1927.....	10,020	1,540	725,360	3.1
1923.....	12,357	1,914	2,808,801	9.8	1928.....	8,115	3,652	735,373	3.1

^a Part of the output in 1919 was elemental arsenic, but the elemental arsenic produced in 1920 and 1921 is not included in the table, as it was reduced from white arsenic purchased on the market. No elemental arsenic was produced from 1922 to 1928.

¹ Figures on imports compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

IMPORTS

Arsenic compounds and metallic arsenic imported for consumption in the United States, 1919-1928

Year	Arsenious acid (white arsenic, As_2O_3)		Arsenic sulphide (realgar and orpiment)		Sheep dip		Paris green and London purple	
	Short tons	Value	Short tons	Value	Pounds	Value	Pounds	Value
1919.....	4, 389	\$624, 494	2, 151	\$316, 687	146, 803	\$12, 346	18	\$14
1920.....	3, 740	532, 635	4, 080	684, 016	70, 168	5, 150	772	277
1921.....	1, 669	253, 250	3, 343	531, 322	61, 377	6, 362	325	123
1922.....	1, 081	162, 494	3, 815	472, 044	70, 390	4, 877	3, 866	741
1923.....	10, 152	1, 985, 400	1, 097	268, 311	87, 739	5, 237	100, 781	20, 586
1924.....	8, 877	1, 597, 433	234	45, 246	114, 801	10, 764	76, 241	15, 683
1925.....	9, 316	1, 076, 073	476	63, 296	73, 477	4, 953	2, 880	702
1926.....	7, 703	510, 227	283	40, 718	119, 947	14, 070	4, 747	1, 011
1927.....	12, 517	921, 998	206	35, 089	102, 394	8, 952	-----	-----
1928.....	11, 153	775, 169	263	51, 278	175, 055	17, 592	13, 279	1, 497

Year	Arsenic acid (H_3AsO_4)		Calcium arsenate		Lead arsenate		Metallic arsenic	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919-1921.....	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
1922 ²	41, 296	\$4, 195	-----	-----	-----	-----	22, 487	\$3, 484
1923.....	166, 354	15, 597	-----	-----	26	\$9	174, 415	37, 314
1924.....	420	121	3, 172	\$278	3, 585	525	122, 467	23, 684
1925.....	59, 112	2, 676	1, 074	135	10, 467	1, 514	149, 018	31, 918
1926.....	2, 340	165	1, 057	284	-----	-----	174, 490	35, 745
1927.....	11, 685	470	3, 807	717	-----	-----	245, 686	47, 875
1928.....	75	30	1, 323	233	-----	-----	186, 622	35, 584

¹ Figures not available.

² Figures cover period Sept. 22 to Dec. 31. Not separately classified prior to change in tariff.

White arsenic imported into the United States in 1928, by countries and districts

[General imports]

Country	Short tons	Value		District	Short tons	Value
		Total	Average (cents per pound)			
Belgium.....	178	\$12, 885	3. 6	Buffalo.....	598	\$49, 168
British Malaya.....	28	1, 217	2. 2	El Paso.....	1, 121	49, 530
Canada.....	1, 582	121, 552	3. 8	Hawaii.....	84	6, 276
Germany.....	47	5, 697	6. 1	Los Angeles.....	66	4, 276
Japan.....	1, 291	52, 794	2. 0	Maryland.....	147	11, 498
Mexico.....	8, 027	581, 024	3. 6	Massachusetts.....	39	1, 962
				Michigan.....	580	41, 927
				New York.....	3, 585	258, 656
				Ohio.....	301	22, 561
				Philadelphia.....	125	10, 086
				San Antonio.....	3, 465	280, 541
				San Francisco.....	1, 042	38, 688
	11, 153	775, 169	3. 5		11, 153	775, 169

MARKET IN 1928

DEMAND AND SUPPLY

In 1928 three smelting companies and one mining company sold by-product arsenic from current production and stock on hand. More than nine-tenths of this arsenic was recovered from the smelting of copper ores and the remainder came from lead ores and gold ore. The chief sources of domestic arsenic were Montana and Utah, where it was recovered from miscellaneous ores and concentrates by the Anaconda Copper Mining Co., the American Smelting & Refining Co., the United States Smelting, Refining & Mining Co., and the Jardine Mining Co. The White Iron Ores & Products Co. reported shipping two cars of arsenical ore in 1928 from Madera, Colo., to Denver, where special compounds (not specified) containing elemental arsenic were made experimentally. This company's property is on Lake Fork of the Gunnison River, just above Sapinero, Colo. It is equipped with a small arsenic kitchen, but the kitchen was not in use in 1928.

For many years insecticide manufacturers have been the largest consumers of arsenic, utilizing more than 60 per cent of the total domestic supply. The use of arsenic for weed-killer and wood-preserver mixtures has increased; about 25 per cent of the total in 1928 was sold for these purposes and 11 per cent was sold to the glass industry. Arsenic of the highest grade is usually sold to insecticide and glass manufacturers and crude arsenic, including "flue" dust and "treater" dust, is used for weed-killer and for wood-preserving purposes.

Imports of crude and refined arsenic during 1928 amounted to 11,153 short tons. As the sales of domestic arsenic amounted to 11,767 tons, the total new supply on the market in the United States was 22,920 tons; this, with the 2,396 tons produced in 1928 but not sold, indicates 25,316 tons as the total new supply of white arsenic available.

Mexico was credited with more than two-thirds of the arsenic imported in 1928. This arsenic was produced at the by-product plants at the Mexican lead works of the American Smelting & Refining Co. and the American Metal Co. The white arsenic plants and the plants for recovering arsenical dust in Mexico are described in a Mexican publication.² Canada exported some of its arsenic to the United States; this arsenic was obtained from treating the arsenical silver-cobalt-nickel sulphide ores of the Cobalt district, Ontario. Arsenical gold concentrates were also shipped from the Nickel Plate gold mine in British Columbia to the Tacoma smelter in Washington. Most of the arsenic imported from Japan, third on the list of sources of imported arsenic, was recovered as a by-product from smelting copper ores.

PRICES

The price quoted in New York for white arsenic delivered at the consuming point was steady at 4 cents a pound during all of 1928, but small lots were quoted at a higher price. The price of 4 cents a pound included freight from the refinery to buyer's works and barrel-

² Boletín Minero, Mexico, vol. 25, No. 4, April, 1928, pp. 255-259.

ing; freight averaged about one-half cent a pound and barreling one-half cent. These items account for the difference between quoted prices and the average value of product as reported by the producers.

Under the tariff act of 1922 arsenious acid or white arsenic is on the free list; metallic arsenic is dutiable at 6 cents a pound, lead arsenate at 3 cents a pound, and calcium arsenate at 25 per cent ad valorem. Under the preceding tariff act—that of 1913—white arsenic or arsenious acid and arsenic acid were both on the free list, as were also arsenic sulphide, realgar and orpiment, sheep dip, and other arsenic compounds, such as Paris green and London purple. Prior to the act of 1913, at least as far back as 1894, the tariff acts specified Paris green and London purple as dutiable, but the other arsenic compounds, including arsenic or arsenious acid, were on the free list.

The Jardine Mining Co., of Jardine, Mont., and other producers of arsenic in the United States petitioned the Committee on Ways and Means, January 8, 1929,³ for a duty of 4 cents a pound on arsenious acid or white arsenic; they claimed that large imports of cheap arsenic keep the price much below actual production costs. Production of arsenic direct from ores has ceased, and none of the plants erected for treating ore for arsenic alone are in operation. The cost of such production in the United States is estimated to be between 7 and 8 cents a pound; the cost to the cheapest producer is 6.35 cents a pound, according to W. C. Bacorn of the Jardine Mining Co.

WORLD PRODUCTION

World production of arsenic ore and white arsenic, 1924–1927, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country and product	1924	1925	1926	1927
Algeria:				
Arsenate of lead—				
Gross weight.....	9,335	6,750	3,665	2,482
Arsenic content.....	1,587	1,215	733	546
Australia:				
New South Wales—				
Ore and concentrates.....	4,487	3,400	^a 1,796	755
White arsenic.....	328	301	202	(^b)
Queensland—				
Ore.....	(^b)	1,133	828	71
White arsenic.....	573			
South Australia—				
Ore—				
Gross weight.....	69	102		
Arsenic content.....	(^b)	(^b)		
Victoria—				
White arsenic.....	437	(^b)	(^b)	(^b)
Austria:				
Ore—				
Gross weight.....	560	89		
Arsenic content.....	40	15		
Arsenic content of gold ores.....	216	237	155	14
Belgium:				
White arsenic.....	1,850	(^b)	(^b)	(^b)
Brazil:				
White arsenic.....	146	(^b)	51	(^b)
Canada:				
White arsenic.....	1,631	910	1,807	2,220
Arsenic content of ores and concentrates ^d	465	648	495	605
China:				
Ore ^d	472	395	(^b)	(^b)
White arsenic ^d	237	94	(^b)	(^b)

^a Exclusive of output of Ottery mine, data for which are not available.

^b Data not available.

^c Exclusive of arsenical gold ores worked primarily for their gold and silver content.

^d Exports.

³ Tariff Readjustment, 1929, Schedule 1; Chemicals, Oils, and Paints: Jan. 7, 8, and 9, 1929.

World production of arsenic ore and white arsenic, 1924-1927, in metric tons—Con.

Country and product	1924	1925	1926	1927
Chosen:				
Ore-----		(b)		
White arsenic-----		107		
Czechoslovakia:				
Ore-----				
Gross weight-----	217	34	4	13
Arsenic content-----	(b)	(b)	1	3
France:				
Ore-----	14,029	30,349	23,256	55,800
White arsenic-----	802	2,217	2,096	(b)
Germany:				
Ore and concentrates e-----				
Gross weight-----	10,818	6,626	3,930	4,710
Arsenic content-----	3,499	2,085	1,353	1,639
Great Britain:				
Ore-----	304	(f)		81
White arsenic and arsenic soot-----	3,258	2,586	1,693	1,358
Greece:				
White arsenic-----	1,096	423	1,148	1,036
Italy:				
Ore-----				
Gross weight-----	147	4	200	81
Arsenic content-----	33	1	35	20
Japan:				
Ore-----	7,416	(b)	(b)	(b)
White arsenic-----	3,703	3,485	1,035	1,713
Mexico:				
White arsenic-----	2,551	7,507	6,458	9,018
Peru:				
Ore-----		(b)		
Arsenic-----		119		
Portugal:				
Ore-----	279	76	7	47
White arsenic-----	874	1,092	354	(b)
Rhodesia, Southern:				
Ore-----				
Gross weight-----	533	170	49	38
Arsenic content-----	(b)	(b)	(b)	(b)
Spain:				
Ore-----				
Gross weight-----			190	186
Arsenic content-----			29	28
Sweden:				
Ore-----				
Gross weight-----	50	110	13,149	22,100
Arsenic content-----	19	21	2,478	4,420
Union of South Africa:				
White arsenic-----	102	33	38	53
United States:				
White arsenic-----	13,111	11,174	10,709	10,487

^b Data not available.

^d Exports.

^e Data relate to concentrates produced and ore sold without concentration.

^f Production reported, but figures not available for publication.

^g White arsenic exported by the Anglo-French Ticapampa Silver Mining Co. (Ltd.).

BISMUTH

Bismuth was reported recovered at two refining establishments in the United States in 1928. Figures of production are not available for publication.

Bismuth imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919-----	57,607	\$55,179	1924 ¹ -----	18,494	\$39,653
1920-----	72,771	161,877	1925 ¹ -----	99,694	187,340
1921-----	94,085	114,891	1926 ¹ -----	67,505	173,285
1922 ¹ -----	121,505	239,777	1927 ¹ -----	47,732	100,773
1923 ¹ -----	62,640	146,178	1928 ¹ -----	41,383	77,444

¹ Also 9,392 pounds of "compounds, mixtures, and salts of bismuth," valued at \$8,681, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to change in tariff. Similar additional imports in 1923 were 11,731 pounds, valued at \$13,717; in 1924, 10,066 pounds, \$12,533; in 1925, 16,983 pounds, \$18,958; in 1926, 12,864 pounds, \$18,864; in 1927, 10,560 pounds, \$15,080; and in 1928, 8,168 pounds, \$16,336.

The average quoted price for bismuth at New York in ton lots was \$1.93 a pound in 1928. The price was \$2.10 during January, rose to \$2.25 in March but before the end of the month was again \$2.10, which price held until the first week of July; the price was \$1.70 during the remainder of the year for ton lots and quotations for small lots were \$1.85 a pound. In London the price during the first part of the year was 8s. a pound; the closing price was 7s. 6d. a pound.

SELENIUM

Three companies reported an output of 419,039 pounds of selenium in 1928, compared with 377,278 pounds in 1927.

The annual sales of selenium from 1921 to 1928, in the form of small pigs, in sticks one-half inch thick and about 4 inches long, and in fairly coarse powder, are given in the table that follows.

Selenium sold by producers and in stock at producers' plants in the United States, 1921-1928

Year	Sales			Stock at end of year (pounds)
	Pounds	Value		
		Total	Average	
1921	55,978	\$89,148	\$1.59	
1922	123,565	177,542	1.44	
1923	127,174	237,196	1.86	677
1924	153,762	286,066	1.86	48,419
1925	194,007	330,637	1.70	61,775
1926	252,312	438,132	1.74	72,374
1927	284,508	491,996	1.73	158,494
1928	362,697	607,382	1.67	(1)

¹ Bureau of Mines not at liberty to publish figures.

Selenium and selenium salts imported for consumption in the United States, 1921-1928

Year	Pounds	Value	Year	Pounds	Value
1921.....	1,106	\$2,099	1925.....	5,807	\$10,582
1922.....	1,652	2,530	1926.....	18,885	34,680
1923.....	940	1,653	1927.....	15,286	28,199
1924.....	300	606	1928.....	18,622	33,998

Quotations in New York for selenium delivered at the consuming point were \$2 to \$2.25 a pound throughout 1928.

TELLURIUM

Final figures for tellurium in 1928 indicate an output of 2,590 pounds, compared with 1,659 pounds in 1927. They also indicate that the sales of tellurium in 1928 amounted to 932 pounds, valued at \$1,731, or an average of \$1.86 a pound, compared with 1,003 pounds, valued at \$1,913, or an average of \$1.91 a pound, in 1927. At the end of 1928 the quantity of tellurium in stock at producers' plants was approximately 4,000 pounds.

PLATINUM AND ALLIED METALS

By V. C. HEIKES ¹

CRUDE PLATINUM

Mine returns for 1928 indicate a production of 150 troy ounces of crude platinum in Alaska, 357 ounces in California, and 21 ounces in Oregon, a total of 528 ounces for the United States. In 1927 Alaska produced 20 ounces, California 127 ounces, and Oregon 6 ounces.

Platinum refiners report purchases of domestic platinum in 1928, as follows: California, 299 ounces and Oregon, 66 ounces—a total of 365 ounces, or 129 ounces more than refiners purchased in 1927. Refiners also report purchases of 57,962 ounces of foreign crude platinum in 1928—1,086 ounces from Australia, 14 ounces from Canada, 53,744 ounces from Colombia, and 3,118 ounces from South Africa; the total is 9,055 ounces more than the purchases reported in 1927. According to the Bureau of Foreign and Domestic Commerce the imports of platinum from Colombia during 1928 were 52,800 ounces, and the total imports of unmanufactured platinum were 108,447 ounces, a decrease of 16 per cent as compared with 1927.

REFINED PLATINUM METALS

NEW METALS

Reports of refiners of crude platinum, gold bullion, and copper indicate that 59,039 ounces of platinum metals were recovered in the United States from these sources in 1928, an increase of 28 per cent as compared with recoveries in 1927. It is estimated that 9,590 ounces of the total in 1928 were derived from domestic sources.

New platinum metals recovered by refiners in the United States, 1919-1928, in troy ounces

Year	Platinum	Palladium	Iridium	Osmiridium	Others	Total
1919.....	40,220	3,807	401	402	279	45,109
1920.....	36,015	4,309	418	409	393	41,544
1921.....	51,791	2,686	286	581	1,026	56,370
1922.....	54,142	1,943	210	1,301	122	57,718
1923.....	46,780	1,934	280	787	16	49,797
1924.....	57,827	6,065	680	1,261	174	66,007
1925.....	41,300	7,358	283	648	54	49,643
1926.....	76,154	6,437	234	2,113	43	84,981
1927.....	41,121	3,879	256	631	163	46,050
1928.....	51,427	5,148	1,658	458	348	59,039

¹ Helen M. Gaylord, of the Bureau of Mines, assisted in the preparation of this report. The figures on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the Bureau of Mines.

New platinum metals recovered by refiners in the United States, 1927 and 1928, by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmiridium	Others	Total
1927						
Domestic:						
Crude platinum.....	84	1	46	30	3	164
Ore.....		108				108
Gold and copper refining.....	4,365	3,528			8	7,901
	4,449	3,637	46	30	11	8,173
Foreign: Crude platinum.....	36,672	242	210	601	152	37,877
Total recovery.....	41,121	3,879	256	631	163	46,050
1928						
Domestic:						
Crude platinum.....	209	1	54	43	14	321
Ore.....	1					1
Gold and copper refining.....	4,421	4,761	31		55	9,268
	4,631	4,762	85	43	69	9,590
Foreign:						
Crude platinum.....	46,784	386	1,573	415	78	49,236
Gold and copper refining.....	12				201	213
	46,796	386	1,573	415	279	49,449
Total recovery.....	51,427	5,148	1,658	458	348	59,039

SECONDARY METALS

Secondary platinum metals are those recovered from the treatment of scrap metal, sweeps, and other waste products of manufacture that contain platinum. Although the figures in the following table undoubtedly contain some duplication, it is believed that they are worth publishing.

Secondary platinum metals recovered in the United States, 1919–1928, in troy ounces

Year	Platinum	Palladium	Iridium	Others	Total
1919.....	54,545	3,467	3,504		61,516
1920.....	51,255	3,100	3,355		57,710
1921.....	39,131	4,887	1,776	229	46,023
1922.....	40,062	4,193	1,937	496	46,688
1923.....	39,152	6,246	2,021	453	47,872
1924.....	45,474	5,784	2,200	1,013	54,471
1925.....	35,578	4,680	1,827	1,189	43,274
1926.....	38,795	5,647	1,478	217	46,137
1927.....	46,127	4,244	1,810	891	53,072
1928.....	47,157	4,156	2,090	2,428	55,831

IMPORTS AND EXPORTS

Platinum metals imported for consumption in the United States, 1919–1928

Year	Troy ounces	Value	Year	Troy ounces	Value
1919.....	68,054	\$6,747,447	1924.....	111,359	\$11,030,349
1920.....	100,546	10,617,440	1925.....	125,802	13,230,148
1921.....	78,378	5,418,464	1926.....	134,797	13,451,835
1922.....	110,025	8,983,547	1927.....	148,769	12,413,494
1923.....	106,637	10,466,705	1928.....	135,233	9,357,737

Platinum metals imported for consumption in the United States, 1927 and 1928, by metals

Metal	1927			1928		
	Troy ounces	Value		Troy ounces	Value	
		Total	Average		Total	Average
Platinum:						
Ores of platinum metals (platinum content).....				686	\$49, 094	\$71. 57
Grains, nuggets, sponge, or scrap.....	90, 491	\$7, 480, 869	\$82. 67	78, 399	5, 298, 665	67. 59
Ingots, bars, sheets, or plates, not less than 1/8 inch thick.....	38, 053	3, 707, 062	97. 42	29, 362	2, 348, 840	80. 00
	128, 544	11, 187, 931	87. 04	108, 447	7, 696, 599	70. 97
Manufactures of, except jewelry.....	37	5, 812	157. 08	39	3, 146	80. 67
Iridium.....	4, 633	520, 202	112. 28	4, 212	672, 384	159. 64
Osmiridium.....	7, 506	397, 408	52. 95	5, 785	418, 829	72. 40
Osmium.....	6	277	46. 17	310	20, 337	65. 60
Palladium.....	6, 251	222, 878	35. 65	13, 463	407, 826	30. 29
Rhodium.....	1, 308	59, 940	45. 83	1, 887	102, 120	54. 12
Ruthenium.....	484	19, 046	39. 35	1, 090	36, 496	33. 48
	148, 769	12, 413, 494	83. 44	135, 233	9, 357, 737	69. 20

Platinum metals (unmanufactured) imported into the United States, 1927 and 1928, by countries, in troy ounces

[General imports]

Country	Platinum			Iridium	Osmium and osmiridium	Palladium	Rhodium and ruthenium	Total
	Ores of platinum metals (platinum content)	Grains, nuggets, sponge, or scrap	Ingots, bars, sheets, or plates, not less than 1/8 inch thick					
1927								
Australia.....		25			852			877
Canada.....		1, 673	6			978	571	3, 228
China.....		5						5
Colombia.....		52, 048	2	136	30	6		52, 222
Cuba.....		1						1
Finland.....				22		66	6	94
France.....		321	1, 934	298		64	344	2, 961
Germany.....		4, 157	22, 421	2, 719	22	50	38	29, 407
Guatemala.....				50	369			419
Latvia.....		19						19
Mexico.....		6						6
Panama.....		611						611
Soviet Russia in Europe.....			4, 179	923				5, 102
United Kingdom.....		31, 625	9, 511	485	6, 239	5, 087	833	53, 780
		90, 491	38, 053	4, 633	7, 512	6, 251	1, 792	148, 732
1928								
Australia.....					290			290
Brazil.....				13				13
Canada.....		1, 475	9			1, 530	438	3, 452
China.....		4						4
Colombia.....	686	52, 120			14			52, 814
France.....				165	551	122	658	1, 496
Germany.....		3, 250	19, 996	1, 856	217	101	8	25, 428
Italy.....		45						45
Japan.....		300	1, 500					1, 800
Soviet Russia in Europe.....		2, 815	3, 168	205				6, 188
Union of South Africa.....	6							6
United Kingdom.....		18, 390	4, 689	1, 973	5, 023	11, 710	1, 873	43, 658
	686	78, 399	29, 362	4, 212	6, 095	13, 463	2, 977	135, 194

Platinum exported from the United States, 1919-1928

Year	Unmanufactured		Manufactures of, except jewelry	
	Troy ounces	Value	Troy ounces	Value
1919.....	522	\$75,066	(1)	\$54,529
1920.....	1,302	177,115	(1)	111,014
1921.....	3,272	244,473	741	85,216
1922 (Crude, scrap, and old Ingots, sheets, wire, and alloys)	143	13,149	486	35,967
1923.....	1,313	127,047		
1924.....	1,151	128,599	592	65,073
1925.....	5,854	643,282	1,274	136,948
1926.....	16,234	1,787,122	3,537	249,975
1927.....	11,573	1,253,795	1,898	160,648
1928.....	19,923	1,577,560	1,549	128,875
	9,050	619,478	2,168	160,554

¹ Quantity not recorded.*Platinum exported from the United States, 1927 and 1928, by countries*

Country	Unmanufactured (ingots, sheets, wire, alloys, and scrap)		Manufactures of, except jewelry	
	Troy ounces	Value	Troy ounces	Value
1927				
Argentina.....	220	\$18,912	635	\$53,931
Bolivia.....			2	326
Brazil.....	1	28		
Canada.....	602	47,810	783	64,890
Chile.....	1	36	13	918
China.....	4	438		
Colombia.....			1	172
Cuba.....			8	48
Czechoslovakia.....			1	64
Denmark.....			(1)	34
France.....	199	12,879		
Germany.....	6,352	558,929	1	66
Honduras.....			3	361
Hungary.....	1	127		
India (British).....			1	73
Italy.....			2	384
Japan.....	10,976	835,419	1	112
Mexico.....			40	2,831
Peru.....	6	491		
Philippine Islands.....			10	180
Siam.....			1	73
Surinam.....			4	480
Sweden.....	100	6,547	1	80
United Kingdom.....	1,461	95,944	39	3,618
Venezuela.....			3	234
	19,923	1,577,560	1,549	128,875
1928				
Argentina.....	100	5,682	79	6,108
Brazil.....	115	9,485	115	13,680
Canada.....	549	51,521	1,168	75,227
Chile.....			32	4,657
China.....			6	403
Colombia.....			12	135
Cuba.....			1	78
France.....	1,350	100,277		
Germany.....	3,467	207,212	208	19,575
Japan.....	2,847	198,560	99	7,397
Mexico.....			3	544
Newfoundland and Labrador.....	1	91		
Panama.....			9	220
Peru.....			4	190
Philippine Islands.....			12	41
Sweden.....			1	141
Switzerland.....	2	110		
Union of South Africa.....			2	344
United Kingdom.....	619	46,540	417	31,814
	9,050	619,478	2,168	160,554

¹ Quantity not recorded.

CONSUMPTION

According to reports from refiners the consumption of platinum metals in the United States in 1928 was 187,287 ounces, an increase of 25 per cent as compared with 1927. The chemical industry used 8,563 ounces more than in 1927, most of which was platinum. The electrical industry used 12,858 ounces more than in 1927, increasing its consumption of platinum and palladium but decreasing its consumption of iridium. The dental industry consumed 3,526 ounces more than in 1927, increasing its consumption of each of the platinum metals. The jewelers increased their consumption by 8,378 ounces, using more platinum and palladium but less iridium. The quantity of platinum metals consumed for miscellaneous uses in 1928 was 9,380 ounces, an increase of 84 per cent as compared with 1927.

Platinum metals consumed in the United States as reported by refiners, 1927 and 1928, by industries, in troy ounces

Industry	Platinum	Palladium	Iridium	Others	Total	Percentage of total
1927						
Chemical.....	11,010	180	101	175	11,466	8
Electrical.....	14,905	2,491	1,618	121	19,135	13
Dental.....	7,504	12,194	153	-----	19,851	13
Jewelry.....	86,036	3,706	4,059	329	94,130	63
Miscellaneous.....	3,176	312	305	1,311	5,104	3
	122,631	18,883	6,236	1,936	149,686	100
1928						
Chemical.....	18,529	1,252	113	135	20,029	11
Electrical.....	21,316	9,150	1,525	2	31,993	17
Dental.....	10,930	12,270	167	10	23,377	12
Jewelry.....	93,468	4,965	3,260	815	102,508	55
Miscellaneous.....	5,431	2,136	963	850	9,380	5
	149,674	29,773	6,028	1,812	187,287	100

STOCKS

Stocks of the platinum metals in the hands of refiners on December 31, 1928, amounted to 78,270 ounces, a decrease of 23 per cent as compared with the stocks at the beginning of the year.

Stocks of platinum metals in the hands of refiners in the United States, December 31, 1919-1928, in troy ounces

Year	Platinum	Palladium	Iridium	Others	Total
1919.....	29,228	10,235	3,359	610	43,432
1920.....	46,747	16,565	4,196	216	67,724
1921.....	38,514	21,042	4,991	3,113	67,660
1922.....	41,900	24,975	7,559	1,583	76,017
1923.....	36,554	26,266	5,208	2,697	70,725
1924.....	40,464	27,400	3,822	3,053	74,539
1925.....	44,024	26,740	3,720	4,609	79,093
1926.....	64,203	31,950	3,933	5,485	105,571
1927.....	68,757	24,313	4,617	4,369	102,056
1928.....	45,710	23,018	4,523	5,019	78,270

MARKET AND PRICES

CRUDE PLATINUM

Sellers of domestic crude platinum reported they were paid for metal content based on assay, and no figure can be given for crude platinum. Buyers reported purchases at \$75 to \$87 an ounce for domestic and \$62 to \$143 for foreign crude platinum. One dealer reported buying a small lot at \$41 an ounce. Buyers of foreign and domestic crude platinum in the United States who reported purchases in 1928 are as follows:

American Platinum Works, 225 New Jersey Railroad Avenue, Newark, N. J.
 Baker & Co. (Inc.), Murray and Austin Streets, Newark, N. J.
 J. Bishop & Co. Platinum Works, Malvern, Pa.
 Sigmund Cohn, 44 Gold Street, New York, N. Y.
 Thomas J. Dee & Co., 1010 Mallers Building, Chicago, Ill.
 Kastenhuber & Lehrfeld, 24 John Street, New York, N. Y.
 Pacific Platinum Works (Inc.), 814 South Spring Street, Los Angeles, Calif.
 R. & H. Platinum Works (Inc.), 709 Sixth Avenue, New York, N. Y.
 Shreve & Co., Post Street and Grant Avenue, San Francisco, Calif.
 L. E. Waterman Co., 140 Thomas Street, Newark, N. J.
 Western Gold & Platinum Works, Phelan Building, San Francisco, Calif.
 Wildberg Bros., 742 Market Street, San Francisco, Calif.
 H. A. Wilson Co., 97 Chestnut Street, Newark, N. J.

REFINED METALS

Quotations ² based on official prices quoted by a leading interest on small miscellaneous orders for refined platinum were \$72 an ounce the first of the year. On January 16 the price increased to \$85 and on March 1 decreased to \$80. It was maintained at \$80 until May 1, when it was reduced to \$78. The price continued at \$78 until November 8; on December 8 it decreased to \$74, the closing price for 1928. The average of these quotations was \$78.88. The open market price for large lots of refined metal averaged \$73 bid and \$76 asked. Refiners reported the high price of platinum at \$90, the low at \$60, and the average for the year as \$75 an ounce.

Iridium, 98 to 99 per cent sponge and powder, was quoted at \$260 to \$280 an ounce the first of the year, but a sudden demand sent the quotations to \$450 the last of January. This price declined in April to \$275 to \$300 and continued within this range to the end of the year; the last quotation was \$275. Refiners gave the following prices: High, \$550; low, \$175; and average for the year, \$294 an ounce.

Quotations on palladium the first of the year were \$49 to \$51 an ounce; early in May they were \$46 to \$49; early in August they were \$42 to \$47; and the last of December they were quoted as \$42 bid and \$44 asked. Refiners reported a high of \$65, a low of \$36, and an average price for the year of \$46 an ounce.

Rhodium quotations ranged from a high of \$65 to \$70 an ounce early in March to a low of \$40 to \$55 the last three months of the year.

Osmium quotations opened the year at \$60 to \$65 and rose to \$80 to \$85 in February, but by March had declined to \$70 to \$75 and by May to \$65 to \$80. From August to early December the price was maintained at \$55 to \$65, and closed the year at \$55 to \$56.

² Engineering and Mining Journal: Vols. 125 and 126, 1928.

Ruthenium quotations opened the year at \$50 to \$55, a week later were \$60 to \$65, and in early February reached \$70 to \$75, the high for the year. Early in March quotations were \$65 to \$70, the first week in May were \$60 to \$65, and the second week were \$45 to \$60. The low for the year—\$45 to \$55—was quoted in mid-September and the year closed at that figure.

WORLD PRODUCTION

World production of crude platinum from placers, 1919-1927, in troy ounces

Country	1919	1920	1921	1922	1923	1924	1925	1926	1927
Australasia:									
New South Wales.....	213	796	249	80	586	646	573	397	226
Papua (osmiridium) ¹	(2)	100	360	100	\$ 145	\$ 119	\$ 116	\$ 49	60
Tasmania (osmiridium).....	1,670	2,009	1,751	1,174	673	365	3,366	3,173	633
Canada.....	⁴ 30	⁴ 25	⁴ 15	⁴ 15	⁴ 10	5	6	50	11
Colombia ⁵	35,000	35,000	35,500	40,000	42,000	46,000	45,000	⁶ 44,565	⁶ 45,830
Ethiopia.....									2,251
Japan.....	155	258	231	150	224	145	189	198	47
Mexico.....								30	
New Zealand.....								31	33
Philippine Islands.....				1	14		4	8	31
Russia.....	⁷ 30,000	⁸ 35,000	⁸ 20,000	⁷ 27,200	⁷ 38,000	⁷ 66,841	⁷ 94,780	⁷ 92,691	⁸ 100,000
United States.....	824	613	977	1,008	609	335	343	286	153

¹ For year ended June 30 of year stated.

² Figures not available, but annual output did not exceed 10 ounces.

³ Exports.

⁴ Estimated by J. M. Hill. The Dominion Bureau of Statistics Ann. Repts. give the placer output of Canada, in troy ounces, as follows: 1919, 25; 1920, 17; 1921, 23; 1922, 12; 1923, 7.

⁵ Estimated.

⁶ Based on data personally communicated to the author.

⁷ Figures as published by the Geological Committee, Russia, in Annual Rept. on the mineral resources of the U. S. S. R., vol. 1, Leningrad, 1927.

⁸ Estimated production, Imp. Inst., London.

The following table gives data by which the figures showing the production of crude platinum as given in the foregoing table can be reduced to terms of the refined metals used by the industries:

Average assay of crude platinum, in per cent

Country	Platinum	Palladium	Iridium	Osmium	Rhodium, ruthenium, etc.
Australasia:					
New South Wales.....	75.9		1.3		1.3
Papua.....			58.1	33.5	3.0
Tasmania.....			58.1	33.5	3.0
Canada.....	72.1	0.2	1.1		2.8
Colombia.....	86.69	.54	1.85		
Japan.....	.2		49.8	37.3	3.9
Russia.....	83.5	1.9	1.9	3.0	.6
United States.....	85.5	.6	1.1	1.3	1.0

Iridium and osmiridium.

NOTES ON PRODUCTION BY COUNTRIES

The following review of production by countries summarizes the information available at time of writing report (July, 1929).

UNITED STATES

The mine production of Alaska in 1928, as reported by the United States Geological Survey, amounted to 150 ounces of crude platinum. About 20 ounces came from placers in the Dime Creek district of the

Seward Peninsula and 130 ounces from the Kuskokwim region. The mine of the Alaska Palladium Co. on Kasaan Peninsula, Prince of Wales Island, was closed in the fall of 1926; it remained idle throughout 1927 and 1928.

In California most of the platinum produced was the by-product of dredges working the gold placers at the base of the Sierra Nevada Mountains. The total quantity of crude platinum sold by mining companies in 1928 was 357 ounces, as compared with 216 ounces in 1927. Refiners reported the purchase of 299 ounces of California crude platinum in 1928.

The production of platinum in Oregon in 1928 was 21 ounces, as compared with 6 ounces in 1927. The refiners reported purchases of 66 ounces of platinum from Oregon during 1928.

No production of platinum metals was recorded from the mines near Holmes, Albany County, Wyo., from which platinum-palladium-bearing copper ores have been produced in the past.

AUSTRALASIA

Production of platinum metals in Australasia in 1927 was as follows: Two hundred and twenty-six ounces from New South Wales (397 ounces in 1926), 60 ounces of osmiridium from Papua (49 ounces in 1926), and 633 ounces of osmiridium from Tasmania (3,173 ounces in 1926). The production of platinum metals in New South Wales³ was all from the Fifield Division. At the end of the year about 30 men were engaged in prospecting. The production of osmiridium in Tasmania was all from the Adams River field.⁴ The report of the Director of Mines⁵ says:

Adamsfield is still the chief source of supply and is receiving more attention of late owing to a considerable rise in the market value.

Osmiridium is now sold by private negotiation to agents of metal dealers and not through a pool. The present method of marketing is much better for the following reasons: (1) Competitive buying results in higher prices; (2) the highest price can be given for the best material; (3) full payment is made immediately; (4) definite contracts can be arranged with individual producers.

It is remarkable that a considerable rise in price coincided with the abandonment of the pooling system of marketing.

The attention of prospectors is directed to the Boyes River area north of Adamsfield, where the serpentine belt is found to extend 6 to 7 miles beyond the outcrops near the confluence with Gordon River. Coarse metal has been found in the far northern part, to which a track has been cut by the Department from the crossing of Florentine River. A track has been opened down Weld River Valley from the South Gordon tract to provide a way of access to serpentine belts in that direction. Prospectors are exploring the country between the south coast and upper Huon River. Osmiridium has been reported between Mount Stewart and Mount Ramsay in the western division.

CANADA

The production of crude platinum in Canada in 1927 was 11 ounces; none is reported for 1928. Platinum refiners in the United States reported purchases of 19 ounces of Canadian crude platinum in 1927 and 14 ounces in 1928. Recoveries of platinum metals in 1927 from Sudbury ores were 11,217 ounces of platinum and 11,545 ounces of other platinum-group metals. Corresponding figures for 1928 are 10,532 ounces and 13,607 ounces, respectively.

³ Annual Report of the Department of Mines, New South Wales, for the year 1927, Sydney, 1928, p. 34.

⁴ Industrial Australian and Mining Standard (Melbourne): Mar. 22, 1928.

⁵ Report of the Director of Mines for the year ended Dec. 31, 1927, Hobart, 1928, p. 13.

The following is an extract from the preliminary report on the Canadian mineral industry in 1927, published by the Department of Mines, Mines Branch, Ottawa, Canada.

With the exception of a very few ounces of platinum obtained from the black sands of British Columbia, all the Canadian platinum and allied metals are obtained from the treatment of the Sudbury nickel-copper matte. The precious metal residues are allowed to accumulate over irregular periods before being treated, so that recoveries do not bear any definite relation to the quantity of matte treated in any particular year.

Canada ranks third in importance as a source of metals of the platinum group, after Russia and Colombia. The recent discoveries of platinum in the Transvaal are of great importance and although only about 5,000 ounces were produced in 1926, over 7,000 ounces were produced for the first 8 months of 1927. The production of Colombia is estimated at 60,000 ounces and that of Russia possibly a little higher.

CHILE

An important platinum find is reported to have been made in 1927 at Rio Gamboa, near Castro, southern Chile.⁶ The report of platinum in black sand deposits of the island of Chiloe, off the coast of Chile, is not new; it was noted in the chapter of this series for 1920 by Hill⁷ who quoted from an article by Mella⁸ describing the deposits. The proportion of black sands on the various beaches varies from a trace to as high as 50 per cent of the deposit. Platinum is found in appreciable quantities only on Tablaruca beach near the extreme southwestern point of the island. The gold, which occurs in thin scales, is about 950 fine, pieces weighing up to 1½ milligrams being not uncommon on the southern beaches, although the gold is much more finely divided in the northern deposits. Samples of the richest streak of sand at Lavaderos beach indicate a value of from 20 to 30 grains of platinum per cubic yard, the clean metal containing about 10 per cent of iridium.

COLOMBIA

The exports of crude platinum from Colombia in 1928 were approximately 54,000 ounces; the production in 1927 was 45,830 ounces. Almost half of the Colombian output is produced by hand-working operations by native operators. Refiners of platinum metals in the United States reported purchases of 53,744 ounces of Colombian crude platinum in 1928 and 43,557 ounces in 1927.

The South American Gold & Platinum Co. in 1927 produced approximately 22,117 ounces of crude platinum and 6,364 ounces of gold, which constituted a record since operations started, but the price received for platinum was materially lower. The reconstruction and electrification of dredge No. 1 was completed in June, 1927; this dredge and dredges Nos. 2 and 3 operated steadily on power furnished by the hydroelectric plant. The recovery of platinum in 1928 by the South American Gold & Platinum Co. should equal if not exceed that in 1927.

ETHIOPIA (ABYSSINIA)

Placer gold and recently platinum were recovered by the primitive methods of natives working the sands of the river beds in western Ethiopia.

⁶ Mining Journal (London), Reported Platinum Find in Chile: Vol. 159, No. 4815, 1927, p. 1007.

⁷ Hill, J. M., Mineral Resources of the United States, 1920, pt. 1, p. 46.

⁸ Mella, Fritz, Black Sand Deposits of the Island of Chiloe: Eng. and Min. Jour., vol. 111, Mar. 19, 1921, pp. 497-501.

The gold output, which is estimated to average \$225,000 annually, is recovered chiefly from the river beds of the Blue Nile, the Dabus and its tributaries, the Beni-Shangul, and the Tumat Rivers. This information was gathered from various sources, including officials of the Bank of Abyssinia⁹ and the Director of the Abyssinian Mint.¹⁰ The crude placer gold is said¹¹ to contain silver, platinum, and copper, and the refined gold a fineness of 950 to 970. The gold is not subject to any taxes or duties by the Abyssinian Government, but the French authorities at Djibouti impose a 5 per cent transit duty. The Wallega and Shangalla districts in the southwestern and western part of Ethiopia produce gold, and the gold from the Gojam district, northwest of the Ankober field, contains some platinum.

Platinum, although previously known, received considerable attention¹² in 1926, when it was found in the bed of the Didessa River. Small native undertakings in gold and tin placer mining were also noted in river bottoms of the Gildessa area in the Harrar district and the Omo region. The output of gold and platinum attained more importance in 1927, although commercial development, only barely begun, lacks transportation facilities. The platinum is washed from the sand by natives who do not employ machinery.

Heretofore, the Ethiopian Government has had no mining bureau, but a German geologist and mineralogist has been employed to initiate such work. Through this agency it was learned¹³ that Ethiopia in 1927 produced 24,000 okiets (okiet equals 0.9 troy ounce) of gold (chiefly alluvial), containing 95 per cent of gold and 5 per cent of silver, and 70 kilos (2,251 troy ounces) of crude platinum metals, containing 80 per cent of platinum and 5 per cent of gold. The gold had a value of 860,000 Maria Theresa dollars (dollar equals 49 cents in United States coin) and the platinum 260,000 Maria Theresa dollars.

A recent publication¹⁴ contains a map of the Beni-Shangul land of western Ethiopia and describes the occurrence of the precious metals. The translation of an article which appeared in an earlier issue of *Metall und Erz* was published in the *American Metal Market* of November 20, 1926; it gave the following information concerning platinum found in Ethiopia.

According to a report of a German engineer, Mr. Robert Hesse, in *Metall und Erz*, there are signs of the commencement of platinum mining activity in Abyssinia. It is a foregone conclusion that that country contains considerable ore deposits but the lack of a mining law has kept out prospectors and capitalists, and even in recent years very little investigation work has been effected. The concession held by the Italian Alberto Prasso for some 20 years now appears to be acquiring practical value, platinum having been recently discovered where gold had already been located. The *Banque de Paris et des Pays Bas*, of Paris, has sent M. Ungemach, the French geologist, to study the concession. In consequence, an option on some 500 square kilometers has been exercised and the *Société Minière des Concessions Prasso* has been founded. A staff of experts is already at work and machinery has been sent down the Nile to the field of operations. For the time being only alluvial deposits are being worked but

⁹ Southard, Addison E. (American consul, Aden, Arabia), Report 1399, Bureau of Mines foreign file, Apr. 20, 1920.

¹⁰ Cross, Cecil M. (American consul, Aden, Arabia), Report 3229, Bureau of Mines foreign file, Mar. 3, 1922.

¹¹ Director of Abyssinian Mint.

¹² Park, J. L. (American vice consul, Aden, Arabia), Report 8955, Bureau of Mines foreign file, Aug. 25, 1926.

¹³ Southard, Addison E. (American consul, Aden, Arabia), Report 8955, Bureau of Mines foreign file, July 18, 1928.

¹⁴ Hesse, R., Occurrence of Precious Metals in Beni-Shangul Land, Western Abyssinia: *Metall u. Erz*, Jahrg. 25, No. 22, Halle a. S., November, 1928, pp. 582-585.

the placers are extraordinarily rich. It is reported that platinum nuggets of up to 15 grammes have been found. Platinum has also been located in another part of the west, in Wallega province, in the form of fine dust in alluvium, a concentrate from which produced by somewhat primitive methods gave a platinum content of 79 per cent on analysis in Berlin.

RUSSIA

The production of crude platinum in Russia in 1927 is estimated at approximately 100,000 ounces. The output of platinum metals in 1928 from the Union of Socialist Soviet Republics (the present official name for Soviet Russia) did not exceed the production of 1927, according to American and English journals,¹⁵ and it is understood the production in 1929 as far as possible will be adjusted to meet consumption. A statement¹⁶ of exports of platinum metals across all frontiers during the past six fiscal (October to September, inclusive) years, furnished by the Amtorg Trading Corporation, is given as follows:

Platinum metals exported from Russia (across all frontiers) in fiscal years ended September, 1923-1928

Fiscal year ended September—	As recorded		Equivalent in troy ounces and dollars		
	Kilograms	Rubles ¹	Troy ounces	Value	
				Total	Average
1923.....	299.1	1,867,000	9,616.29	\$960,758	\$99.91
1924.....	838.4	5,733,000	26,955.18	2,950,202	109.45
1925.....	2,924.6	19,010,000	94,028.06	9,782,546	104.04
1926.....	4,098.3	26,639,000	131,763.39	13,708,429	104.04
1927.....	5,073.1	26,569,000	163,103.93	13,672,407	83.83
1928.....	2,454.9	9,820,000	78,926.86	5,053,372	64.03

¹ The ruble equals \$0.5146.

It is difficult to account for the distribution of the Russian exports to other countries, but of the exports out of Russia in 1926 the United Kingdom¹⁷ received 138,919 ounces of crude platinum, compared with 7,700 ounces in 1927. The United States received none direct from Russia in 1926 but received 5,102 ounces of ingot platinum and iridium in 1927 and 6,188 ounces of platinum and iridium in 1928.

An article entitled "The History of the Russian Platinum Industry" was published in the December 29, 1928, issue of the Mining Journal (London), pages 1094 to 1095.

Albert Linde,¹⁸ Director of the Edelmetalle-Vertriebe A. G., Berlin, has recently discussed the problems of the platinum market.

UNION OF SOUTH AFRICA

The shipments of platinum in South Africa in 1928 totaled 17,828 ounces, compared with 10,431 ounces in 1927. The value of sales in 1928 amounted to £241,110, compared with £144,191 in 1927.¹⁹

Osmiridium recovered in the treatment of the Rand "banket" gold ores in 1927 was 5,472.52 ounces, and sales of osmiridium during 1927 amounted to 5,653.18 ounces, valued at £58,137.²⁰ In 1928 the ship-

¹⁵ Metal Bulletin (London): Jan. 22, 1929.

¹⁶ Statement published on Soviet trade, Sovetskaya Torgovlya, No. 50, 1928.

¹⁷ Metal Bulletin (London): Jan. 8, 1929.

¹⁸ Linde, Albert, Problems of the Platinum Market: Min. Jour. (London), Jan. 26, 1929, p. 10.

¹⁹ Transvaal Chamber of Mines, Executive Report for 1928, p. 10.

²⁰ Annual Report of the Secretary for Mines and Industries, Union of South Africa, 1927, pp. 36-37.

ments amounted to 5,991 ounces, valued at £86,921.²¹ The average price received for osmiridium in 1928 was £14.509 per ounce compared with £10.284 in 1927 and £15.210 in 1926. Most of the osmiridium recovered in 1927 was from the large mines in the Witwatersrand district; only 9.23 ounces was saved in the Heidelberg district. For the 5,653.18 ounces sold in 1927 the following average analysis was obtained.

Analysis of osmiridium from the Witwatersrand and Heidelberg districts in 1927

	Per cent	Weight of metal (troy ounces)
Osmium.....	30. 51	1, 724. 902
Iridium.....	28. 32	1, 601. 031
Ruthenium and rhodium.....	13. 51	763. 879
Platinum.....	10. 74	606. 939
Gold.....	2. 62	147. 942
Balance (undetermined).....	14. 30	808. 487
	100. 00	5, 653. 180

The content of the elemental metals varies and, taking as an example the osmiridium from large gold mines of the Witwatersrand only, the following are the minimum and maximum percentages:

	Mini- mum per- centage	Maxi- mum per- centage		Mini- mum per- centage	Maxi- mum per- centage
Osmium.....	24. 82	41. 36	Platinum.....	4. 48	15. 70
Iridium.....	22. 07	36. 55	Gold.....	. 01	12. 64
Ruthenium and rhodium.....	10. 29	15. 41			

In addition to the platinum content of the osmiridium recovered from the treatment of gold ores, platinum was produced for the first time in South Africa in 1926 from working the "Bushveld Igneous Complex" and the hortonolite dunite deposits of the Potgietersrust and Lydenburg districts. The output of these districts for 1927, as given in the government report for South Africa, follows.

Platinum produced in the Potgietersrust and Lydenburg districts in 1927

	Quantity	Assay	Estimated contents platinum metals (ounces)
Crude platinum.....	17,429.301 ounces.....	74.25 per cent.....	12, 941. 041
Concentrates.....	580.911 tons.....	11.41 ounces per ton.....	6, 629. 193
			19, 570. 234

Sales of platinum metals amounted to 10,431.397 fine ounces, valued at £144,191.

The output of osmiridium from the beginning of production to the end of 1927 is valued at £492,246 and that of platinum at £237,498. These metals were produced in the Transvaal.

During 1928 development was continued on the platinum-bearing formations of the Transvaal in the Lydenburg, Potgietersrust, and Rustenburg districts; production continued at Onverwacht, Potgietersrust, and Maandagshoek.

²¹ See footnote 19.

The metallurgists report²² that no difficulties remain in making a high-grade concentrate containing the precious metals. Flotation of the Rustenburg ore has been improved to the extent that on sulphide ore a 90 per cent extraction and on oxidized ore a 65 per cent extraction is obtained. In the more difficult matter of recovering refined metals from the concentrates it has become a question of choosing rather than of finding a process. The Chemical & Metallurgical Corporation put its plant at Runcorn, England, into operation; the output of this plant will equal that of the pilot plant in the Potgietersrust district. This pilot plant has been operating since September, 1926, and 1,122 tons of concentrate has accumulated; it is estimated to contain 4,516 ounces of platinum, 4,767 ounces of palladium, 193 ounces of other platinum metals, 284 ounces of gold, 44 tons of nickel, and 23 tons of copper. The value has been estimated at £110,000, on the basis of prices considerably below those at present. It is understood that the new plant for treating ores containing platinum, which is being constructed at Rustenburg for the Potgietersrust Platinum (Ltd.), will be in operation in September, 1929.

R. A. Cooper reports²³ a new platinum mineral found in the norites of the Rustenburg district of the Transvaal. The mineral has a brilliant metallic luster and under the microscope resembles sperrylite. The new mineral is more easily crushed than sperrylite and when reduced to an impalpable powder is nearly insoluble in concentrated aqua regia. It is a sulpharsenide of platinum containing 64.2 per cent of platinum, 9.4 per cent of palladium, 17.7 per cent of sulphur, and 7.7 per cent of arsenic. This combination conforms to the formula $Pt(SAs)_2$.

Recent discoveries in the treatment of platinum ore in South Africa have put into use a successful process that may make possible an increased yield of platinum metals. The editor of the South African Mining and Engineering Journal,²⁴ however, believes the English participation in the platinum market is still a matter requiring an agreement with Russian producers. It is a foregone conclusion that Russian producers of platinum can probably continue for many years to produce the cheapest platinum from placers.

The process referred to above is described in a recent article,²⁵ from which the following paragraphs are quoted.

Methods of extracting platinum from the norite and pyroxenite ores of the Transvaal continue to absorb the attention of British metallurgists. Various processes have been experimented with, and success is claimed by the sponsors of at least four of these—namely, the methods evolved by the metallurgical staff of the Central Mining-Rand Mines group; the Chemical & Metallurgical Corporation of London's process; the Eklund patents; and the Summerton process. The Central Mining-Rand Mines' process has been worked out at the Ferreira laboratory, where a small pilot plant has been installed. * * *

Time alone, and much further work not only in the laboratory but in commercial plant operation, can prove the relative merit of the various methods; but it now seems clear that at least one of the methods is likely to solve the platinum problem in South Africa. After the metallurgical method of treatment has been worked out and decided upon, both in respect to extraction and unit cost, the greater problems of marketing and of control of production and of price will require solution. For, if an effective method is found of extracting

²² Mining and Industrial Magazine (Johannesburg): Dec. 12, 1928, pp. 309, 361, 362.

²³ Journal of the Chemical, Metallurgical and Mining Society of South Africa: June, 1928, pp. 281-283.

²⁴ South African Mining and Engineering Journal: Vol. 39, pt. 2, Sept. 15, 1928, pp. 53, 55.

²⁵ Engineering and Mining Journal, Developments in Platinum Metallurgy: Vol. 127, Jan. 5, 1929, p. 10.

platinum from low-grade norite and pyroxenite ores (of which there is a tremendous tonnage in the Transvaal and in Rhodesia), a greater quantity of platinum and its associated metals than the world can readily absorb may become available, with resultant market demoralization. There would then be the inevitable adjustments, though eventually of course the true price level would be found, and, despite the triumph of metallurgical research, the lower-grade ventures would cease to be profitable.

The following paragraph is quoted from the Mining Magazine of London.²⁶

Some excellent finds of platinum ore are said to have been made recently by prospectors in the Rustenburg district, Transvaal. The discoveries are not upon the presumed line of the Merensky reef, for the shafts and cuttings lie at a much lower horizon, generally between the two chromite lines. Whatever the value of the actual results may be as showing a definite and fairly extended line of reef, they are of interest from a geological point of view, and suggest the question as to whether they may be genetically related to the pseudo-stratified platiniferous occurrence on the Merensky horizon.

On May 22, 1928, the Eerstegeluk Platinum Mines (Ltd.) and the Schildpadnest Association were absorbed by the Potgietersrust Platinums (Ltd.).²⁷ The latter company improved its corduroy concentration and flotation practice at its reduction works in the Potgietersrust district during the year, thus making a higher grade concentrate without increasing the value of the residues. The ore treated amounted to 26,980 tons; it came from the Vaalkop-Zwartfontein and Zwartfontein Central ore bodies. The 698.8 tons of concentrate recovered was estimated to contain 2,886 ounces of platinum, 2,677 ounces of palladium, and 93 ounces of other platinum metals; it also contained 178 ounces of gold, 23 tons of nickel, and 13 tons of copper.

The Eerstegeluk Platinum Mines (Ltd.)²⁸ operating mines in the Lydenburg and Rustenburg districts reports 5,815 feet of development work for 1927, 4,910 feet of which was sampled over an average width of 36 inches and was found to contain 5.3 pennyweights of platinum metals to the ton. To the end of June, 1927, the total ore developed amounted to 544,300 short tons which, after making allowance for surface and shaft pillars, would leave 369,300 tons of available ore. The original sampling of all pits over the whole length of the company's holdings (17,500 feet) indicated that the ore reserves averaged 6.5 pennyweights of platinum metals over a width of 30 inches and sampling of 5,755 feet of development at 5-foot intervals to a depth of 905 feet indicated 5.3 pennyweights of platinum metals.

According to the report of Lydenburg Platinum Areas (Ltd.)²⁹ the additions made to the mill of the company in March, 1927, resulted in increasing its capacity; 36,924 tons of ore was treated during the year ended June 30, 1928, compared with 16,868 tons the previous year. The cost of milling the ore in 1928 was 27s. 11d., compared with 40s. 10d. in 1927.

The report states that 10,710 ounces of "metallics" were recovered during the year ended June 30, 1928, and that 10,322 ounces of "metallics," containing 6,782 fine ounces of platinum-group metals, were sold. In addition to the metallics the company has shipped to the Chemical & Metallurgical Corporation at Runcorn, England, since beginning of production, 114 tons of gravity and flotation concentrates averaging 9.83 ounces of platinum to the ton.

²⁶ Mining Magazine (London), More Platinum Discoveries: Vol. 39, No. 6, December, 1928, pp. 372-373.

²⁷ Annual Report for 11 months ended Sept. 30, 1928.

²⁸ Annual Report for year ended June 30, 1927.

²⁹ Annual Report for year ended June 30, 1928.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES ¹

By J. P. DUNLOP

SUMMARY

The mines of the Eastern States yielded metals in 1928 valued as follows: Gold, \$35,097; silver, \$59,974; copper, \$4,256,517; and zinc, \$19,516,228. There was only one producer of lead and the Bureau of Mines is not at liberty to publish the figures. Both the quantity and value of each of the five metals increased in 1928, compared with 1927.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in the Eastern States, 1919-1928

Year	Mines producing	Ore sold or treated (short tons)	Gold (lode and placer)		Silver (lode and placer)	
			Fine ounces	Value	Fine ounces	Value
1919.....	(a)	1,930,411	341.14	\$7,052	104,690	\$117,253
1920.....	(a)	2,418,500	411.91	8,515	112,183	122,279
1921.....	27	1,502,277	480.55	9,934	98,792	98,792
1922.....	29	2,274,175	620.22	12,821	80,935	80,935
1923.....	21	2,936,637	576.58	11,919	108,799	89,215
1924.....	16	2,851,932	799.88	16,535	97,628	65,411
1925.....	19	3,315,912	1,964.60	40,612	106,228	73,722
1926.....	21	2,902,670	694.23	14,351	106,539	66,480
1927.....	15	3,201,195	825.96	17,074	84,293	47,794
1928.....	21	3,770,070	1,697.82	35,097	102,520	59,974

* Figures not available.

¹ Mineral Resources, 1908, Pt. I, pp. 645 to 681, contains references to the geology of the Eastern States and gives a list of the U. S. Geological Survey, State survey, and other publications that deal with the geology and mines of those States; Mineral Resources, 1914, Pt. I, pp. 139 to 163, contains a historical review of the production of gold in the Southern Appalachian States and a list of U. S. Geological Survey publications on gold, silver, copper, lead, and zinc in the Eastern States.

Mine production of gold, silver, copper, lead, and zinc in the Eastern States, 1919-1928—Continued

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919	16, 596, 182	\$3, 086, 890	4, 378, 000	\$232, 034	241, 766, 000	\$22, 552, 371	\$25, 995, 600
1920	17, 138, 675	3, 153, 516	4, 003, 078	320, 246	206, 764, 000	20, 673, 444	24, 278, 000
1921	15, 397, 596	1, 986, 290			135, 422, 000	10, 521, 030	12, 616, 046
1922	15, 476, 497	2, 089, 327	1, 472, 000	80, 960	188, 082, 000	13, 616, 900	15, 881, 033
1923	20, 487, 395	3, 011, 647	2, 500, 000	175, 000	199, 180, 000	14, 765, 885	18, 053, 666
1924	19, 450, 329	2, 547, 993	4, 424, 000	353, 920	212, 148, 000	16, 875, 606	19, 859, 465
1925	20, 824, 058	2, 957, 016	5, 354, 000	465, 798	226, 814, 000	18, 531, 644	22, 068, 792
1926	21, 567, 100	3, 019, 394	6, 500, 000	520, 000	207, 196, 000	16, 365, 050	19, 985, 275
1927	22, 327, 734	2, 924, 933	4, 786, 000	301, 518	236, 340, 000	16, 836, 047	20, 127, 366
1928	29, 559, 146	4, 256, 517	(b)	(b)	288, 090, 000	19, 516, 228	(b)

^b Bureau of Mines not at liberty to publish figures for lead.

GOLD AND SILVER

In the Eastern States the output of gold was \$35,097 in 1928 compared with \$17,074 in 1927. The output of the lode gold and placer mines, which formerly supplied nearly all the gold, was insignificant in 1928, as the lode gold mines produced only \$1,120 in gold and the placer mines only \$820. There was more development done at gold mines in 1928 than in 1927, and this work may result in increased yield of gold in 1929 and 1930. Very little gold ore was milled, except in experimental plants. No gold was reported from Alabama or Virginia mines in 1928. Placer mines were worked in Georgia, North Carolina, South Carolina, and Tennessee and lode gold mines in Georgia and North Carolina; all were small producers. Refining of copper bullion from ore mined in North Carolina, Tennessee, and Pennsylvania yielded \$33,157 in gold, of which \$1,841 came from North Carolina copper ore, \$20,506 from Pennsylvania pyritiferous magnetite ore, and \$10,810 from Tennessee copper ore. The value of the estimated production of gold of the Southern Appalachian States for the period 1799 to 1928 is \$51,151,252.

Of the silver (102,520 ounces) produced in the Eastern States in 1928 all except 3 ounces from gold placers and 16 ounces from lode gold mines was derived from copper bullion recovered from copper ore and pyritiferous magnetite ore.

Mine production of gold and silver in the Eastern States in 1928, by States

State	Gold		Silver		Increase or decrease in value as compared with 1927	
	Fine ounces	Value	Fine ounces	Value	Gold	Silver
Georgia	44. 07	\$911	5	\$3	—\$131	—\$1
North Carolina	114. 46	2, 366	19, 051	11, 145	+1, 351	+11, 142
Pennsylvania	991. 98	20, 506	7, 905	4, 624	+14, 305	+3, 490
South Carolina	9. 53	197	1	1	+197	+1
Tennessee	537. 78	11, 117	75, 558	44, 201	+2, 301	—1, 987
Vermont						—465
Total, 1927	1, 697. 82	35, 097	102, 520	59, 974	+18, 023	+12, 180
	825. 96	17, 074	84, 293	47, 794		

Mine production of gold and silver in the Eastern States in 1928, by sources, in fine ounces

State	Gold			Silver		
	Placers	Dry and siliceous ore	Copper ore	Placers	Dry and siliceous ore	Copper ore
Georgia.....	12.34	31.73			5	
North Carolina.....	2.95	22.45	89.06		11	19,040
Pennsylvania.....			991.98			7,905
South Carolina.....	9.53			1		
Tennessee.....	14.85		522.93	2		75,556
	39.67	54.18	1,603.97	3	16	102,501
Total, 1927.....	99.51		726.45	12		84,281

COPPER

The mine production of copper in the Eastern States in 1928 was 29,559,146 pounds, valued at \$4,256,517, an increase of 7,231,412 pounds over 1927. The output was derived from copper ore mined in North Carolina and Tennessee and from copper concentrates recovered from Pennsylvania pyritiferous magnetite ore mined for its iron content. The quantity of ore treated to produce this copper was 1,916,465 short tons. Exclusive of the magnetite ore, which yields about 5 pounds of copper to the ton, the average yield of copper from copper ore was 1.47 per cent, or 29.5 pounds to the ton. The copper ore also yielded \$0.082 in gold and silver to the ton. The copper concentrates from magnetite ore contain about 26.5 per cent of copper and \$2.68 in gold and silver to the ton. Copper ore directly smelted amounted to 456,681 tons, from which 15,477,691 pounds of copper was recovered. Copper and magnetite ores concentrated amounted to 1,459,784 tons and yielded 51,408 tons of concentrates, from which 14,081,455 pounds of copper was recovered. The main feature of the copper production in the Eastern States in 1928 was the large output from the Fontana mine in Swain County, N. C.

LEAD

The only output of lead reported from the Eastern States in 1928 was from the Austinville mine in Virginia, as the Embree mine in Tennessee shipped no lead ore. The production was derived from lead-zinc ore and was larger than in 1927. The Bureau of Mines is not at liberty to publish the figures for 1928.

ZINC

The recoverable zinc in the ore mined in the Eastern States in 1928 was valued at \$19,516,228.

[N. B.—The value of the zinc in New Jersey is not that of ore mined. It is the estimated smelting value of the recoverable zinc content of the ore after freight, haulage, smelting, and manufacturing charges are added.]

In 1928, 648,797 short tons of zinc ore were mined in New Jersey and 570,199 tons in Tennessee, and 125,192 tons of crude ore and old tailings were treated in New York. The ore mined in Virginia was

lead-zinc sulphide ore. All the zinc ore and lead-zinc ore mined in New York, Tennessee, and Virginia went to concentrating plants; part of the New Jersey ore was not concentrated. The recoverable zinc, as metal or in oxide, in the ore mined in New York in 1928 was 22,514,000 pounds; Tennessee and Virginia contributed 65,834,000 pounds of zinc.

REVIEW BY STATES

Alabama.—The value of the gold produced by mines in Alabama during the period 1830 to 1928 was \$766,746. None has been reported since 1923. So far as known to the Bureau of Mines no lode or placer mine was under development in 1928.

Georgia.—The value of the gold produced in Georgia during the period 1830 to 1928 was \$17,845,084, or more than one-third of the estimated total output of the Southern Appalachian States. In 1928 two placer mines and one lode mine yielded \$911 in gold and 5 ounces of silver. The output in 1927 was \$1,042 in gold and 7 ounces of silver. The gold produced in 1928 came from small properties near Auraria in Lumpkin County, Gainesville in Hall County, and Washington in Wilkes County. The Dugas Corporation did no placer mining at Dahlonega, Lumpkin County, but continued development of its lode mines. The ore is opened by an inclined shaft and drifts and is said to average \$8 in gold a ton. At the end of 1928 the company had completed the installation of a 60-ton amalgamating and concentrating plant; the mill was first operated in January, 1929. A cyanide plant will be added to the equipment. Ore from the Turkey Hill, Cabbage Patch, and Chestatee mines of Craig R. Arnold at Dahlonega yielded a little gold in a 5-stamp testing plant, but this gold was not marketed in 1928. A small experimental cyanide plant is to be erected. Two additional tunnels driven in 1928 are said to have opened a large quantity of low-grade auriferous sulphides. The ore at the Cabbage Patch mine, as developed, is a low-grade saprolite; the Turkey Hill mine yields free milling oxidized gold ore. The Saprolite Gold Mining Co. (Inc.) hydraulicked several thousand tons of saprolite ore. The largest gold-producing mine in Georgia in 1928 was the Stoney Ridge mine near Washington in Wilkes County.

Maine, Maryland, New Hampshire, and Vermont.—No production of gold, silver, or copper was reported for 1928 from any of the mines in Maine, Maryland, New Hampshire, or Vermont. The estimated total gold production of Maryland has been \$71,405, virtually all of which was produced prior to 1906. The old Elizabeth mine at South Strafford, Orange County, Vt., which has pyrrhotite ore containing gold and silver and which is equipped with a 150-ton flotation plant, was idle in 1928. It is reported that the property is under option and may be reopened in 1929.

New Jersey (see also p. 23).—The production of zinc ore in New Jersey in 1928 was 648,797 short tons; the ore contained 199,742,000 pounds of recoverable zinc. All the ore mined was treated by the producer for recovery of metal and oxide.

New York.—The quantity of zinc ore mined and old tailings rerun in New York in 1928 was 125,192 short tons; the concentrates recovered yielded 22,514,000 pounds of zinc. The St. Joseph Lead Co.

property is equipped with a 250-ton flotation plant to handle crude ore and a 275-ton flotation plant to treat old tailings. The mill equipment includes a gyratory crusher and rod mills. The ore was mined from a maximum depth of 1,500 feet by means of one shaft; another shaft was utilized for supplies and mine labor. The company did considerable exploration work and opened a new body of ore which will be mined in the future.

North Carolina.—The value of the gold produced in North Carolina during the period 1799 to 1928 was \$23,663,453. The yield of gold increased from \$1,015 in 1927 to \$2,366 in 1928. Only a few mines were active, and very little gold ore was milled; all the gold was recovered from one placer and four lode mines. Most of the gold came from copper ore mined in Swain County. The small output of placer gold was from Cabarrus County; the only producing lode gold mines were in Caldwell and Montgomery Counties. The production of copper ore at the Fontana mine on Eagle Creek in Swain County was much larger than in 1927. The ore was shipped to the Ducktown Chemical & Iron Co., Isabella, Tenn., where about 20 per cent of it was concentrated and the remainder directly smelted. The ore, which is chalcopyrite and pyrrhotite in mica schist and talc gangue, is mined through a vertical shaft and lateral drifts and is hand sorted before shipment. The McKenzie mine in Caldwell County, owned by W. A. Chittenden, was worked for six months in 1928 and a few tons of siliceous ore was milled at a small plant. The Hercules mine in Caldwell County, near Morganton, was operated by the Independent Mining & Milling Co. in the fall of 1928 and a small quantity of bullion was recovered. The Leeper hydraulic mine near Belmont in Gaston County, a large producer in 1927, was not operated in 1928. A little bullion was marketed from the Rich Cog mine near Reidsville, in Montgomery County. At the Howie mine at Waxhaw, owned by the Jackson Gold Mining Co., the shaft was deepened; no ore was treated at the 100-ton cyanide plant.

Pennsylvania.—The Cornwall iron mines in Lebanon County were actively worked by the Bethlehem Mines Corporation and yielded 9,378 short tons of copper concentrates from pyritiferous magnetite. The tailings from the iron concentrates go to the flotation plant where they are ground to 65 mesh and floated in Minerals Separation Sub-A flotation machines. The concentrates, which are shipped to eastern smelters, contain about 27 per cent of copper and about \$2.68 to the ton in gold and silver. The gold recovered from these concentrates was 58 per cent of the total from all mines in the Eastern States in 1928.

South Carolina.—Mines in South Carolina yielded \$5,182,815 in gold during the period 1829 to 1928. The production in 1928 came from the Brewer placer in Chesterfield County and from small placer prospects in Lancaster County.

Tennessee.—Mines in Tennessee produced \$323,313 in gold during the period 1831 to 1928. Most of the output prior to 1879 was from placer mines in Monroe County, but the production from 1906 to 1927 came entirely from copper ores mined in Polk County; a little gold was recovered from placers in 1928. There were increases in

1928 in the quantity and value of gold, copper, and zinc, especially in copper and zinc. There were no shipments of lead ore in 1928.

Mine production of gold, silver, copper, lead, and zinc in Tennessee, 1919-1928

Year	Ore sold or treated	Gold	Silver	Copper	Lead	Zinc	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1919-----	1, 227, 534	\$5, 662	98, 288	15, 623, 589	4, 376, 000	46, 494, 000	\$6, 647, 723
1920-----	1, 120, 995	5, 830	110, 719	16, 727, 803	3, 957, 000	38, 434, 000	6, 634, 144
1921-----	889, 122	4, 920	98, 762	15, 084, 294	-----	19, 384, 000	3, 018, 756
1922-----	983, 844	4, 320	78, 341	14, 240, 571	1, 464, 000	31, 136, 000	3, 860, 410
1923-----	1, 355, 547	6, 615	105, 712	18, 721, 932	2, 500, 000	31, 800, 000	5, 182, 823
1924-----	1, 443, 159	6, 800	94, 779	18, 335, 635	1, 874, 000	28, 752, 000	4, 491, 070
1925-----	1, 711, 298	7, 421	102, 949	19, 788, 234	896, 000	32, 512, 000	5, 437, 660
1926-----	1, 114, 400	8, 622	104, 000	18, 606, 664	1, 600, 000	24, 196, 000	4, 621, 151
1927-----	1, 152, 155	8, 816	81, 460	14, 940, 595	-----	20, 800, 000	3, 343, 421
1928-----	1, 330, 194	11, 117	75, 558	16, 374, 261	-----	¹ 65, 834, 000	¹ 6, 429, 086

¹ Includes zinc from mine in Virginia, for which Bureau of Mines is not at liberty to publish figures.

The entire output of copper in Tennessee in 1928 came from two properties in the Ducktown district which also produced all the gold except \$307 and all the silver except 2 ounces.

The Annette Mines Co. operated the old Coker Creek placer mines in Monroe County early in 1928 and shipped a small quantity of bullion. No details of the development done by this company were received by the Bureau of Mines.

The Tennessee Copper Co. ran its 900-ton flotation plant (capacity increased in 1928 by 300 tons), 1,500-ton blast furnace, Pierce Smith converter, sulphuric acid plant, and copper sulphate works on sulphide ore from the Burra Burra and Eureka mines. About 12,260 feet of development work was done in 1928.

The Ducktown Chemical & Iron Co. operated its 600-ton flotation plant, 600-ton blast furnace, and one converter on sulphide ore and concentrates from the Mary, Isabella, and East Tennessee mines; most of the crude ore was sent to the concentrating plant. The crude ore from the Fontana mine in North Carolina was also treated by the Ducktown Chemical & Iron Co.; 20 per cent of this ore was concentrated and the remainder was directly smelted.

The Ocoee copper mine and concentrating plant were not operated in 1928.

The Grasselli Chemical Co. discontinued work on its New Market property after shafts had been sunk and drifts run; the property will probably be sold before being operated again.

The Universal Exploration Co. continued to develop its property at New Market by means of shafts and drifts. The ore shipped in 1928 was all zinc carbonate, as the property has not been equipped with a mill to treat the sulphide ore. The carbonate ore is mined at levels between 20 and 50 feet, treated in a log washer, and shipped to zinc oxide plants.

F. C. Caldwell, of New Market, also shipped zinc carbonate in 1928; he will build a log washing plant to handle the ore now on the dump.

Developments at the Embree mine near Embreeville disclosed new ore bodies of zinc carbonate of high grade. A good output was made in 1928 and shipments will be increased in 1929.

Operations at the Mascot mine of the American Zinc Co. of Tennessee were more extensive in 1928 than in 1927. The mine has two 700-foot shafts. The fully equipped 2,500-ton flotation-concentration plant was run steadily on ore from the mine. The company drilled land near Jefferson City and started sinking a shaft on the Jarnegan land late in 1928. The new property will be on a producing basis in 1929, when the crude ore will be shipped by rail to the plant at Mascot.

Virginia.—The value of the gold produced from mines in Virginia during the period 1828 to 1928 was \$3,298,436, of which only about \$9,200 was produced during the last 18 years. No production of gold has been reported from Virginia since 1925. Virginia made a record output of lead and zinc in 1928. This output was derived solely from one mine in Wythe County and the Bureau of Mines is not at liberty to publish the figures. Some drilling was done near Austinville and a shaft is being sunk, but the only productive lead and zinc mine in Virginia in 1928 was the Austinville mine of the Bertha Mineral Co. This company mines lead-zinc sulphide ore and treats it in its 1,500-ton flotation-concentration plant. This mill ran steadily all the year.

IRON ORE, PIG IRON, AND STEEL

By HUBERT W. DAVIS¹

GENERAL REVIEW

In 1928 the production and the shipments of iron ore increased 1 and 4 per cent, respectively, as compared with 1927. The production ranked about with that of 1913 and was 99 per cent of the average for the preceding 5 years and 105 per cent of the average for the preceding 10 years. The output of pig iron, including ferro-alloys, increased 4 per cent, as compared with 1927, and was about 103 per cent of the average for the preceding 5 years and 114 per cent of the average for the preceding 10 years. The output of pig iron in 1928 was about equal to that of 1917.

The average value per ton of iron ore at the mines in 1928 was 1 cent lower than in 1927, and that of pig iron at the blast furnaces declined \$1.26 a ton. The quoted price of ferromanganese was higher, but the price of spiegeleisen was lower. Earnings of 22 of the leading steel manufacturers in the United States, according to the Iron Trade Review,² showed a return on capitalization of 6.55 per cent in 1928, as compared with 5.22 per cent in 1927.

According to Iron Age,³ automobiles, for the first time in the history of the industry, have taken the leading place in consumption of steel, with 18 per cent of the total in 1928, as compared with 14 per cent in 1927. Building and other construction of all kinds (except that for railroads) accounted for 16.5 per cent, as compared with 22 per cent in 1927. The railroads, which had held first position year after year until they were displaced by building and other construction in 1927, have now been relegated to third position, with 16 per cent of the aggregate tonnage. Among the smaller outlets for steel production, the oil, gas, water, mining, and lumbering industries accounted for 9.5 per cent of the total, exports and agriculture absorbed 6.5 per cent each, containers took 5 per cent, and machinery accounted for 3.5 per cent.

The total domestic output of pig iron required about 74 per cent of the annual capacity, according to figures of the American Iron and Steel Institute, but this capacity was not utilized steadily. At the beginning of 1928 there were 178 furnaces in blast; on June 30 there were 195; and at the end of the year there were 203. The production of steel ingots is considered to have been about 81 per

¹ Figures on imports and exports compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

² Hill, J. W., Large Volumes, Efficiency Aid to Steel Profits During 1928: Iron Trade Review, vol. 84, Mar. 28, 1929, pp. 854-855.

³ Iron Age, Industries and States Receiving Steel in 1928: Vol. 123, Jan. 3, 1929, pp. 7-9.

cent of the capacity, having ranged from about 74 per cent in June to 91 per cent in October. The output of pig iron in the United States in 1928 represented only about 44 per cent of the world production and was about 15 per cent less than that of the producing countries of Europe combined. The production of pig iron in Europe was about the same in 1928 as in 1927, but the production of pig iron in the United States increased 4 per cent.

The iron-ore mining industry in the Lake Superior district was more active in 1928 than in 1927, although it was below the average for the preceding five years. Eastern furnaces took about 350,000 tons of Lake ore in 1928; they again bought mainly foreign ores, which they could get more cheaply. A computation of iron-mining costs in Michigan in 1928, made by the State mine appraiser, shows that the operators' gross profit at underground mines was 65.7 cents a ton, as compared with 59.1 cents a ton in 1927, and that the cost at siliceous open-pit mines in 1928 was 1.2 cents a ton more than the Lake Erie value in that year. These figures are probably representative of the entire Lake Superior district and show the ability of the operators, in the face of a maintained wage scale, to effect economies in an industry already highly specialized and efficient. The season of 1928 ended with stock piles smaller than at the close of 1927. The total decrease in stocks in the Lake Superior district amounted to 10 per cent.

IRON ORE

QUANTITIES MINED AND SHIPPED IN 1928

In the accompanying table the quantities of iron ore shown include ore that was beneficiated—that is, treated in any way—as well as crude ore not requiring treatment. The figures on both production and shipments include the iron ore used for fluxing other metallic ores at smelters in the Western States, but the shipments do not include the iron ore sold for the manufacture of paint, which amounted to 15,906 gross tons in 1928, valued at \$83,190, or \$5.23 a ton, compared with 22,342 tons in 1927, valued at \$132,007, or \$5.91 a ton. The output of manganoferous iron ore (including ore used for flux) that contained 5 per cent or more of manganese amounted to 1,177,632 gross tons, valued at \$3,053,307, as compared with 1,461,608 tons, valued at \$3,947,016, in 1927. In Arkansas one producer shipped a small quantity of loadstone, which is not included in the tabulated statistics of iron ore. Neither do the statistics include iron sinter recovered from copper sulphide ore, 85,496 gross tons of which, averaging 64.74 per cent of iron, was made in Tennessee in 1928.

Iron ore was mined in 17 States in 1928, as compared with 18 States in 1927, North Carolina having dropped out. All the iron ore produced in Montana and a small part of that produced in Utah was used for flux; a small quantity of ore from New Jersey was used for purifying gas; all the output from Washington was used in the manufacture of ferromagnesite; the ore produced in the remaining States was mainly for use in blast furnaces; small quantities produced in Alabama, Michigan, New Jersey, New York, Pennsylvania, Tennessee, and Wisconsin were used for paint. The rank

of the three States producing the largest quantity of iron ore—Minnesota, Michigan, and Alabama—remained unchanged. Minnesota is producing more iron ore than all the rest of the States together and has furnished a little more than 59 per cent of the total for the United States in the last five years.

The ores of iron are classed under the four heads—hematite, brown ore, magnetite, and carbonate.⁴

Iron ore mined in the United States, 1927 and 1928, by States and varieties, in gross tons

[Exclusive of ore containing 5 per cent or more of manganese]

State	Number of active mines	Hematite	Brown ore	Magnetite	Carbonate	Total
1927						
Alabama.....	23	5,859,304	586,160	-----	-----	6,445,464
Colorado.....	1	-----	32,206	-----	-----	32,206
Georgia.....	5	-----	50,312	-----	-----	50,312
Michigan.....	70	15,075,079	-----	-----	-----	15,075,079
Minnesota.....	95	35,461,138	-----	-----	-----	35,461,138
Missouri.....	2	78,605	-----	-----	-----	78,605
Montana.....	5	(^a)	^a 2,837	-----	-----	2,837
New Jersey.....	2	-----	-----	220,660	-----	220,660
New Mexico.....	1	-----	-----	214,747	-----	214,747
New York.....	6	(^b)	-----	^b 853,159	-----	853,159
North Carolina.....	1	-----	-----	32,528	-----	32,528
Pennsylvania.....	3	-----	-----	1,167,942	2,493	1,170,435
Tennessee.....	6	87,373	34,541	-----	-----	121,914
Utah.....	2	^a 221,009	^a 1,870	-----	-----	222,879
Virginia.....	2	29,040	35,552	-----	-----	64,592
Washington.....	1	-----	-----	550	-----	550
Wisconsin.....	6	1,091,118	-----	-----	-----	1,091,118
Wyoming.....	1	602,877	-----	-----	-----	602,877
	232	^a ^b 58,505,543	^a 743,478	^b 2,489,586	2,493	61,741,100
1928						
Alabama.....	24	5,668,493	639,351	-----	-----	6,307,844
Colorado.....	1	-----	52,713	-----	-----	52,713
Georgia.....	4	-----	73,052	-----	-----	73,052
Michigan.....	64	13,676,984	-----	-----	-----	13,676,984
Minnesota.....	84	37,564,005	-----	-----	-----	37,564,005
Missouri.....	2	94,899	-----	-----	-----	94,899
Montana.....	3	-----	1,640	-----	-----	1,640
New Jersey.....	3	-----	-----	250,332	-----	250,332
New Mexico.....	1	-----	-----	184,623	-----	184,623
New York.....	5	(^b)	-----	^b 712,757	-----	712,757
Pennsylvania.....	3	-----	-----	1,022,080	1,790	1,023,870
Tennessee.....	6	83,662	45,266	-----	-----	128,928
Utah.....	1	320,655	-----	-----	-----	320,655
Virginia.....	2	23,287	4,615	-----	-----	27,902
Washington.....	1	-----	-----	1,012	-----	1,012
Wisconsin.....	6	1,284,592	-----	-----	-----	1,284,592
Wyoming.....	1	491,280	-----	-----	-----	491,280
	211	^b 59,207,857	816,637	^b 2,170,504	1,790	62,197,088

^a Some hematite included with brown ore.

^b Some hematite included with magnetite.

⁴ Notes on the composition of these ores are given in Mineral Resources, 1916, Part I, pp. 537-541.

Iron ore mined in the United States, by mining districts and varieties, 1927 and 1928, in gross tons

[Exclusive of ore containing 5 per cent or more of manganese]

District	Hematite	Brown ore	Magnetite	Carbonate	Total
1927					
Lake Superior ¹ -----	51,539,880				51,539,880
Birmingham-----	5,857,326	437,487			6,294,813
Chattanooga-----	89,351	70,897			160,248
Adirondack-----					
Northern New Jersey and southeastern New York-----			² 1,073,819		² 1,073,819
Other districts-----	² ³ 1,018,986	³ 235,094	1,415,767	2,493	² 2,672,340
	² ³ 58,505,543	³ 743,478	² 2,489,586	2,493	61,741,100
1928					
Lake Superior ¹ -----	52,517,175				52,517,175
Birmingham-----	5,658,021	509,173			6,167,194
Chattanooga-----	94,134	98,372			192,506
Adirondack-----					
Northern New Jersey and southeastern New York-----			² 963,089		² 963,089
Other districts-----	² 938,527	209,092	1,207,715	1,790	² 2,357,124
	² 59,207,857	816,637	² 2,170,804	1,790	62,197,088

¹ Includes only those mines in Wisconsin that are in the true Lake Superior district.

² Some hematite from "Other districts" included with magnetite from Adirondack district.

³ Some hematite included with brown ore.

The Lake Superior district, which comprises Minnesota, Michigan, and northern Wisconsin, mined a little more than 84 per cent of the total ore produced in 1928, and the Birmingham district mined a little less than 10 per cent. The Lake Superior, Chattanooga, and northern New Jersey and southeastern New York districts each produced more ore in 1928 than in 1927.

The following table shows the production of iron ore in the United States so far as it has been recorded or estimated. The figures for the years prior to 1860 are not strictly accurate, as they were calculated from the pig iron produced and included both imported and domestic ore. Details for 1880 to 1916 may be found in Mineral Resources for 1916.

Iron ore mined in the United States, 1810-1928, in gross tons

[Exclusive after 1905 of ore containing 5 per cent or more of manganese]

Year	Hematite	Brown ore	Magnetite	Carbonate	Total
1810-1869-----					49,656,000
1870 ¹ -1880-----					51,690,889
1881-1890-----					103,854,386
1891-1900-----	136,961,046	22,845,764	14,634,364	1,065,137	175,506,311
1901-1910-----	364,179,432	² 28,287,994	² 20,664,453	262,366	413,394,245
1911-1915-----	259,419,251	8,355,102	10,156,539	42,495	257,973,387
1916-----	70,728,024	1,904,484	2,533,364	1,800	75,167,672
1917-----	70,743,513	1,992,332	2,553,006		75,288,851
1918-----	65,894,709	1,613,844	2,149,725		69,658,278
1919-----	³ 57,719,582	1,127,397	³ 2,118,439		60,965,418
1920-----	³ ⁴ 63,883,523	⁴ 1,325,661	³ 2,391,541	3,740	67,604,465
1921-----	³ ⁴ 28,337,249	⁴ 370,154	³ 780,866	2,709	29,490,978
1922-----	⁴ 44,888,723	⁴ 783,582	1,452,966	3,256	47,128,527
1923-----	⁴ 65,924,454	⁴ 1,232,848	2,190,624	3,516	69,351,442
1924-----	⁴ 52,102,300	⁴ 814,159	1,347,711	3,249	54,267,419
1925-----	⁴ 59,546,690	⁴ 884,600	1,472,004	4,703	61,907,997
1926-----	⁴ ⁵ 64,634,573	⁴ 810,924	⁵ 2,175,288	2,215	67,623,000
1927-----	⁴ ⁵ 58,505,543	⁴ 743,478	⁵ 2,489,586	2,493	61,741,100
1928-----	⁵ 59,207,857	816,637	⁵ 2,170,804	1,790	62,197,088
					1,854,467,453

¹ Includes ore produced by owners of blast furnaces, estimated by census at 800,000 tons.

² Some brown ore included with magnetite.

³ Some magnetite included with hematite.

⁴ Some hematite included with brown ore.

⁵ Some hematite included with magnetite.

The ore reported as sold for flux other than that used in the smelting of pig iron amounted to 7,586 gross tons, valued at \$12,215, as compared with 17,287 tons, valued at \$26,051, in 1927. The ore reported sold for purifying gas amounted to 1,484 gross tons, valued at \$8,904, as compared with 1,361 tons, valued at \$8,261, in 1927. The domestic iron ore sold for the manufacture of pig iron amounted to 63,422,744 gross tons, valued at \$155,759,441, as compared with 61,213,275 tons, valued at \$151,087,933, in 1927.

Iron ore shipped from mines in the United States, 1927 and 1928, by States

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint]

State	1927		1928	
	Gross tons	Value	Gross tons	Value
Alabama.....	6,508,419	\$12,973,597	6,159,863	\$11,599,176
Colorado.....	32,206	(1)	52,713	(1)
Georgia.....	50,312	147,068	73,052	209,877
Michigan.....	14,532,831	37,135,364	14,241,102	37,039,644
Minnesota.....	35,563,177	87,935,099	38,129,018	94,258,899
Missouri.....	78,605	315,670	94,899	377,847
Montana.....	2,837	10,156	1,640	5,900
New Jersey.....	202,720	860,393	350,616	1,357,877
New Mexico.....	214,747	(1)	184,623	(1)
New York.....	936,850	4,568,224	767,743	2,906,055
North Carolina.....	32,528	81,753		
Pennsylvania.....	1,124,883	2,559,916	1,013,791	2,411,114
Tennessee.....	121,220	274,620	128,478	286,524
Utah.....	222,879	(1)	320,655	(1)
Virginia.....	66,897	172,877	27,970	83,114
Washington.....	550	(1)	1,012	(1)
Wisconsin.....	937,935	2,567,078	1,394,371	3,700,797
Wyoming.....	602,877	(1)	491,280	(1)
Undistributed.....		² 1,524,005		² 1,551,833
	61,232,473	151,125,820	63,432,826	155,788,657

¹ Included under "Undistributed."

² This figure includes value for States entered as "(1)" above.

Iron ore shipped from mines in the United States, 1919-1928

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint]

Year	Gross tons	Value	Year	Gross tons	Value
1919.....	56,372,784	\$197,312,517	1924.....	52,083,375	\$151,307,105
1920.....	69,281,341	285,006,327	1925.....	63,924,763	160,796,886
1921.....	26,652,528	89,745,308	1926.....	69,292,832	174,015,645
1922.....	50,612,620	157,809,286	1927.....	61,232,473	151,125,820
1923.....	69,811,472	240,738,921	1928.....	63,432,826	155,788,657

PRINCIPAL IRON-ORE MINES

In 1928, 211 iron-ore mines were active, compared with 232 in 1927 and 233 in 1926; 124 mines produced more than 100,000 gross tons of iron ore each, compared with 131 in 1927 and 140 in 1926. Of these 124 mines 10 (7 in Minnesota, 2 in Alabama, and 1 in Michigan) produced more than 1,000,000 tons each, compared with 10 (6 in Minnesota, 2 in Alabama, 1 in Michigan, and 1 in Pennsylvania) in 1927 and 12 (9 in Minnesota, 2 in Alabama, and 1 in Michigan) in 1926. The operators of all of these large mines have permitted the publication of output; the figures are given in the table that follows.

The predominance of hematite as an iron ore is clearly shown by the fact that of these 124 large mines only 4 produced magnetite and 1 produced brown ore. The trend toward large mining units is shown in the production of more than 95 per cent of the output of the country by the 124 mines, which yielded more than 100,000 tons each. The 10 mines that produced more than 1,000,000 tons each in 1928 furnished 36 per cent of the total. The average production per mine in 1928 was 294,773 tons, as compared with 226,125 tons in 1927.

Iron-ore mines of the United States that produced more than 100,000 gross tons each in 1928

Rank	Name of mine	State	Nearest town	Variety of ore	Gross tons
1	Missabe Mountain	Minnesota	Virginia	Hematite	5,255,987
2	Red Mountain group	Alabama	Bessemer	do	3,334,036
3	Mahoning	Minnesota	Hibbing	do	2,832,475
4	Sellers	do	do	do	2,441,002
5	Hull-Rust	do	do	do	1,885,200
6	Adams-Spruce group	do	Eveleth	do	1,773,894
7	Morris	do	Hibbing	do	1,431,961
8	Woodward, Nos. 1, 2, and 3	Alabama	Bessemer	do	1,112,630
9	Leonidas	Minnesota	Eveleth	do	1,085,742
10	Norrie group	Michigan	Ironwood	do	1,025,831
11	Cornwall	Pennsylvania	Miners Village	Magnetite	975,377
12	Hill Annex	Minnesota	Calumet	Hematite	906,556
13	Burt (including Pool and Day)	do	Hibbing	do	820,851
14	Morrison	do	Coleraine	do	790,144
15	Frazer	do	Chisholm	do	701,640
16	Pioneer	do	Ely	do	680,587
17	Dunwoody	do	Chisholm	do	668,470
18	Sloss Nos. 1 and 2	Alabama	Bessemer	do	637,243
19	Shenango	Minnesota	Chisholm	do	626,118
20	Ironton	Michigan	Bessemer	do	625,100
21	Fayal	Minnesota	Eveleth	do	618,223
22	Wakefield	Michigan	Wakefield	do	616,762
23	Hawkins	Minnesota	Nashauk	do	608,580
24	Witherbee, Sherman & Co. group	New York	Mineville	Magnetite	605,861
25	Wabigon	Minnesota	Buhl	Hematite	599,393
26	Newport (including Bonnie)	Michigan	Ironwood	do	586,229
27	Plymouth	do	Wakefield	do	556,401
28	Sauntry	Minnesota	Virginia	do	529,333
29	Areturus	do	Marble	do	501,324
30	Susquehanna	do	Hibbing	do	500,046
31	St. Paul	do	Keewatin	do	499,227
32	Sunrise	Wyoming	Sunrise	do	491,280
33	Hill-Trumbull	Minnesota	Marble	do	488,897
34	Wacotah	do	Mountain Iron	do	480,915
35	Negaunee	Michigan	Negaunee	do	460,015
36	Montreal No. 4	Wisconsin	Montreal	do	452,782
37	Harrison	Minnesota	Pengilly	do	441,901
38	Bennett	do	Keewatin	do	441,484
39	La Rue	do	Nashauk	do	436,071
40	Chapin	Michigan	Iron Mountain	do	434,852
41	Asteroid (including Eureka)	do	Ramsay	do	413,499
42	Volunteer	do	Palmer	do	410,604
43	Raimund Nos. 1 and 2	Alabama	Bessemer	do	405,003
44	Seranton	Minnesota	Hibbing	do	404,717
45	Corsica	do	Gilbert	do	399,384
46	Cliffs Shaft	Michigan	Ishpeming	do	391,862
47	Sibley	Minnesota	Ely	do	388,865
48	No. 5 Shaft	Wisconsin	Montreal	do	376,770
49	Morris-Lloyd	Michigan	Ishpeming	do	356,164
50	Bristol (including Youngstown)	do	Crystal Falls	do	355,427
51	Wellington	Minnesota	Chisholm	do	353,409
52	Penn group	Michigan	Norway and Vulcan	do	352,752
53	Sunday Lake	do	Wakefield	do	344,568
54	Zenith	Minnesota	Ely	do	341,295
55	Biwabik (including Cincinnati)	do	Biwabik	do	329,847
56	South Agnew	do	Buhl	do	326,593
57	Desert Mound	Utah	Iron Springs	do	320,655
58	Alexandria	Minnesota	Chisholm	do	320,326
59	Danube	do	Bovey	do	312,707
60	Berkshire	Michigan	Stambaugh	do	307,169
61	North Harrison	Minnesota	Pengilly	do	305,402
62	Sargent	do	Keewatin	do	302,766
63	Wade	do	Kinney	do	298,212
64	Harold	do	Stuntz	do	294,244

Iron-ore mines of the United States that produced more than 100,000 gross tons each in 1928—Continued

Rank	Name of mine	State	Nearest town	Variety of ore	Gross tons
65	Patrick.....	Minnesota	Pengilly.....	Hematite.....	291,729
66	Puritan.....	Michigan	Ironwood.....	do.....	283,272
67	Lincoln.....	Minnesota	Virginia.....	do.....	270,799
68	Utica.....	do.....	Hibbing.....	do.....	264,844
69	Maas.....	Michigan	Negaunee.....	do.....	261,454
70	James.....	do.....	Iron River.....	do.....	259,565
71	Kerr.....	Minnesota	Hibbing.....	do.....	259,424
72	Armour No. 1.....	do.....	Crosby.....	do.....	257,430
73	Ottawa.....	Wisconsin	Montreal.....	do.....	255,321
74	Caspian.....	Michigan	Iron River.....	do.....	247,997
75	Archibald.....	do.....	Gwinn.....	do.....	242,689
76	Athens.....	do.....	Negaunee.....	do.....	241,570
77	Armour No. 2 (including Cuy- una-Duluth).....	Minnesota	Crosby.....	do.....	234,290
78	Aragon.....	Michigan	Norway.....	do.....	233,753
79	Lake Superior.....	do.....	Ishpeming.....	do.....	227,451
80	Bruce.....	Minnesota	Chisholm.....	do.....	225,616
81	Riverton group.....	Michigan	Iron River.....	do.....	220,499
82	Balkan (including Judson).....	do.....	Alpha.....	do.....	214,998
83	Bengal.....	do.....	Iron River.....	do.....	213,642
84	Albany.....	Minnesota	Hibbing.....	do.....	204,716
85	So. Uno (G. N.).....	do.....	Stuntz.....	do.....	199,248
86	Rogers.....	Michigan	Iron River.....	do.....	198,225
87	Cary and Windsor.....	Wisconsin	Hurley.....	do.....	191,313
88	Glen.....	Minnesota	Chisholm.....	do.....	190,297
89	Hiawatha.....	Michigan	Iron River.....	do.....	190,070
90	Union Hill (including Republic).....	New Mexico	Fierro.....	Magnetite.....	184,623
91	Holmes.....	Michigan	Ishpeming.....	Hematite.....	183,787
92	Virgil.....	do.....	Iron River.....	do.....	180,403
93	Croft.....	Minnesota	Crosby.....	do.....	178,905
94	Homer.....	Michigan	Iron River.....	do.....	167,560
95	Godfrey.....	Minnesota	Chisholm.....	do.....	162,287
96	Zimmerman.....	Michigan	Gaastra.....	do.....	161,814
97	Bates.....	do.....	Iron River.....	do.....	161,428
98	Maroco.....	Minnesota	Ironton.....	do.....	159,941
99	Soudan.....	do.....	Soudan.....	do.....	159,442
100	Mississippi.....	do.....	Keewatin.....	do.....	157,002
101	Laura.....	do.....	Hibbing.....	do.....	156,133
102	Shannon.....	Alabama	Birmingham.....	do.....	155,203
103	Richmond.....	Michigan	Palmer.....	do.....	153,556
104	Mt. Hope.....	New Jersey	Wharton.....	Magnetite.....	151,651
105	Evergreen.....	Minnesota	Crosby.....	Hematite.....	148,829
106	Loretto.....	Michigan	Loretto.....	do.....	148,345
107	Warner.....	do.....	Amasa.....	do.....	144,715
108	Palms.....	do.....	Bessemer.....	do.....	138,656
109	Isabella.....	do.....	Palmer.....	do.....	137,966
110	Quinn.....	Minnesota	Pengilly.....	do.....	131,548
111	Forbes.....	Michigan	Iron River.....	do.....	131,493
112	Cambria (including Lillie).....	do.....	Negaunee.....	do.....	128,266
113	Keweenaw.....	do.....	Bessemer.....	do.....	127,455
114	Shaw.....	Minnesota	Virginia.....	do.....	124,937
115	Wanless.....	do.....	Buhl.....	do.....	119,467
116	Davidson No. 1.....	Michigan	Iron River.....	do.....	118,597
117	Ogden.....	do.....	Ishpeming.....	do.....	116,415
118	Tobin.....	do.....	Crystal Falls.....	do.....	112,035
119	Kinney.....	Minnesota	Kinney.....	do.....	109,653
120	Mary Ellen.....	do.....	Biwabik.....	do.....	105,808
121	Russellville.....	Alabama	Russellville.....	Brown ore.....	104,858
122	Hoadley.....	Minnesota	Nashwauk.....	Hematite.....	104,374
123	West Davis.....	Michigan	Ironwood.....	do.....	102,433
124	York.....	Minnesota	Nashwauk.....	do.....	100,988
Total (124 mines).....					59,183,445
Output of 28 mines producing between 50,000 and 100,000 gross tons each.....					2,081,470
Output of 59 mines producing less than 50,000 gross tons each.....					932,173
Grand total of United States (211 mines).....					62,197,088

STOCKS OF ORE AT MINES

According to the reports of producers, the total quantity of iron ore in stock at the mines at the end of 1928 amounted to 9,190,061 gross tons, compared with 10,104,673 tons at the end of 1927, a decrease of 9 per cent. As the quantity of ore in stock piles is of necessity partly estimated, resulting variations in the mine reports

from year to year prevent an absolute balance between the quantity mined, the quantity shipped, and the stocks on hand. The reported stocks at the end of 1928 were lower than in any year in the period 1919 to 1927 and were 1,418,474 tons below the average for the 5-year period 1923 to 1927.

Stocks of iron ore at mines December 31, 1927 and 1928, by States, in gross tons

State	1927	1928	State	1927	1928
Alabama.....	848, 850	996, 751	New York.....	116, 774	71, 732
Iowa.....	12, 165	12, 165	Pennsylvania.....	85, 322	93, 611
Michigan.....	6, 089, 053	5, 556, 372	Virginia.....	22, 060	20, 287
Minnesota.....	2, 518, 000	2, 079, 823	Wisconsin.....	243, 585	290, 004
Missouri.....	2, 629	2, 629			
New Jersey.....	166, 235	66, 687		10, 104, 673	9, 190, 061

VALUE OF ORE PER TON

The table that follows gives the average value at the mines of the different classes of iron ore in 1927 and 1928 for each of the producing States or groups of States except where the shippers of a certain variety of ore in a State were less than three and permission was not given to publish the value. These figures are taken directly from statements of the producers and probably represent the commercial selling prices only approximately, as all the reports are not consistent. Some of them evidently include mining costs only; others contain, in addition, the cost of selling and insuring the ore; others include an allowance for a sinking fund; and still others include only the costs charged against the blast furnaces. None of the reports, however, is supposed to include freight charges.

Average value per gross ton of iron ore at mines in the United States, 1927 and 1928

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint]

State	Hematite		Brown ore		Magnetite	
	1927	1928	1927	1928	1927	1928
Alabama.....	\$1. 93	\$1. 82	\$2. 58	\$2. 38	-----	-----
Georgia.....	-----	-----	2. 92	2. 87	-----	-----
Michigan.....	2. 56	2. 60	-----	-----	-----	-----
Minnesota.....	2. 47	2. 47	-----	-----	-----	-----
Missouri.....	4. 02	3. 98	-----	-----	-----	-----
Montana.....	(1)	-----	¹ 3. 58	3. 60	-----	-----
New Jersey.....	-----	-----	(2)	(2)	\$4. 23	\$3. 87
New York.....	-----	-----	-----	-----	4. 88	3. 79
North Carolina.....	-----	-----	-----	-----	2. 51	-----
Pennsylvania.....	-----	-----	-----	-----	2. 28	2. 38
Tennessee.....	2. 10	1. 94	2. 69	2. 77	-----	-----
Virginia.....	2. 82	2. 81	2. 38	3. 77	-----	-----
Wisconsin.....	2. 74	2. 65	-----	-----	-----	-----
Other States ²	1. 21	1. 29	2. 99	2. 49	1. 98	2. 00
	2. 43	2. 43	2. 62	2. 47	3. 38	3. 04

¹ Value for hematite included with brown ore.

² Less than three producers; permission to publish not given, therefore value may not be shown

³ Colorado, New Mexico, Utah, Washington, and Wyoming.

The following table summarizes the average value of iron ore at the mines from 1916 to 1928. Not until 1917 did the average value rise above \$3 a ton, and the average for 1920, \$4.11, is the highest on record.

Average value per gross ton of iron ore at mines in the United States, 1916-1928

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint]

Year	Hematite	Brown ore	Magnetite	Carbonate	General average ¹
1916-----	\$2.32	\$2.03	\$3.11	\$3.00	\$2.34
1917-----	3.12	2.95	4.29	-----	3.15
1918-----	3.35	3.51	4.60	-----	3.39
1919-----	3.48	3.63	4.08	-----	3.50
1920-----	4.99	4.19	4.59	(²)	4.11
1921-----	3.37	2.63	3.61	(²)	3.37
1922-----	3.14	2.65	2.37	(²)	3.12
1923-----	3.46	2.88	3.34	(²)	3.45
1924-----	2.91	2.75	2.95	(²)	2.91
1925-----	2.50	2.78	3.07	(²)	2.52
1926-----	2.49	2.83	3.13	(²)	2.51
1927-----	2.43	2.62	3.38	(²)	2.47
1928-----	2.43	2.47	3.04	(²)	2.46

¹ Average values in 1889 and 1892-1915 are given in Mineral Resources for 1919 and many earlier volumes.

² Sold for paint and not included in shipments of iron ore.

³ Carbonate of iron, used in making pig iron, was sold by 1 producer in Ohio in 1924 and 1925; that from Pennsylvania was sold for paint.

IRON ORE CONSUMED

The furnaces in Alabama in making 1 ton of pig iron consumed in 1928 an average of 2.461 tons of ore, the highest average for any State. The greater part of the iron ore used in Alabama furnaces in 1928 was hematite from mines in Jefferson County, Ala.; a small quantity of hematite from Etowah County, Ala., was also used. The brown ore used was obtained chiefly from mines in the Birmingham and Russellville districts, Alabama, and the Cedartown district, Georgia, and the manganiferous iron ore was chiefly from mines in Alabama, Arkansas, Georgia, and Virginia.

In 1928 the furnaces in Maryland used only foreign ores, obtained chiefly from Chile and Cuba, although some were obtained from Algeria, Australia, Morocco, Spain, and Sweden. The Maryland furnaces consumed an average of only 1.426 tons of ore in making 1 ton of pig iron in 1928, but they used proportionately more cinder, scale, and scrap than the furnaces in Alabama.

The furnaces in Indiana, Kentucky, Michigan, Minnesota, and West Virginia used Lake Superior iron ore and manganiferous iron ore exclusively in 1928; the furnaces in Ohio used, in addition to some magnetite from New York, ore chiefly from the Lake Superior district; and the furnaces in Wisconsin used ore from mines in the Lake Superior district and from the Mayville mine in southern Wisconsin. In 1928 the consumption of ores per ton of iron made ranged from 1.347 tons in Kentucky to 1.829 tons in Indiana.

The furnaces in the Chicago district, including Joliet, Ill., used iron ore and manganiferous iron ore from mines in the Lake Superior district; those at Granite City, Ill., used ore chiefly from mines in the Lake Superior district and in addition used ore from the Iron

Mountain and Ruepple mines in Missouri. An average of 1.829 tons of ore was used to make 1 ton of pig iron in 1928.

In New York the furnaces in the Buffalo district used ores from the Lake Superior district and from Mineville, N. Y.; the furnaces at Port Henry used magnetite from the Old Bed and Harmony mines at Mineville, N. Y., and the furnace at Standish used magnetite from the Chateaugay mine at Lyon Mountain, N. Y. In making 1 ton of pig iron the furnaces in New York used an average of 1.878 tons of ore in 1928.

The furnaces in western Pennsylvania used ores mostly from the Lake Superior district. Those in the eastern part of the State used, in addition to some Lake ores, magnetites from the Cornwall and French Creek mines in Pennsylvania; magnetites from the Cannon, Peters, Mt. Hope, Beach Glen, and Richard mines in New Jersey; magnetites from the Old Bed, Harmony, No. 21, and Forest of Dean mines in New York; and considerable quantities of ores from Africa, Brazil, Chile, Cuba, Newfoundland, Spain, and Sweden. An average of 1.673 tons of ore was used in Pennsylvania in 1928 to make 1 ton of pig iron.

The iron furnaces in Tennessee used brown ore from Wrigley and Bon Aqua, Tenn.; hematite from the Rockwood area, Tenn.; brown ore from the Bartow and Reed mines in Georgia and from the Taits Gap mines in Alabama; and mangani ferous iron ore from Tennessee. An average of 2.014 tons of ore was used per ton of iron made in 1928.

Virginia iron furnaces used chiefly local hematite and brown ore. These furnaces used 0.897 ton of cinder, scale, and scrap to 1 ton of pig iron, the highest average for any State. The consumption of ore per ton of iron made was 1.066 tons in 1928.

The blast furnaces at Pueblo, Colo., used brown ore from the Orient mine in Colorado, hematite from the Sunrise mine in Wyoming and from the Desert Mound mine in Utah, magnetite from the Union Hill mine in New Mexico, and mangani ferous iron ores from Leadville, Colo., and Silver City, N. Mex.

The blast furnace at Provo, Utah, used iron ore chiefly from the Desert Mound mine in the Iron Springs district, Utah. The mangani ferous iron ore used was obtained from Idaho, Montana, and Utah.

The following two tables show the consumption of iron ore and other metallic materials, the production of pig iron (as reported to the Bureau of Mines), and the average quantities of materials used per ton of pig iron made.

Iron ore and other metallic materials consumed and pig iron produced in 1928, by States, in gross tons

State	Metalliferous materials consumed				Pig iron produced, exclusive of ferro-alloys	Materials consumed per ton of iron made		
	Iron and manganiferous iron ores		Cinder, scale, and scrap	Total		Ores	Cinder, scale, and scrap	Total
	Domestic	Foreign						
Alabama.....	6, 123, 553	70, 997	182, 516	6, 377, 066	2, 517, 485	2. 461	0. 072	2. 533
Illinois.....	7, 211, 856	-----	516, 111	7, 727, 967	3, 943, 558	1. 829	. 131	1. 960
Indiana.....	7, 018, 416	-----	550, 208	7, 568, 624	3, 838, 626	1. 829	. 143	1. 972
Kentucky.....	303, 719	-----	101, 748	405, 467	225, 545	1. 347	. 451	1. 798
Maryland.....	-----	1, 381, 163	241, 856	1, 623, 019	968, 277	1. 426	. 250	1. 676
Michigan.....	1, 222, 721	-----	98, 298	1, 321, 019	744, 439	1. 643	. 132	1. 775
Minnesota.....	529, 470	-----	85, 092	614, 562	332, 215	1. 594	. 256	1. 850
New York.....	4, 129, 677	-----	188, 790	4, 318, 467	2, 198, 380	1. 878	. 086	1. 964
Ohio.....	15, 330, 463	-----	1, 642, 031	16, 972, 494	9, 020, 969	1. 699	. 182	1. 881
Pennsylvania.....	19, 135, 384	1, 031, 976	2, 263, 819	22, 431, 179	12, 054, 976	1. 673	. 188	1. 861
Tennessee.....	184, 145	-----	12, 626	196, 771	91, 431	2. 014	. 138	2. 152
Utah.....	327, 344	-----	-----	327, 344	165, 702	1. 975	-----	1. 975
Virginia.....	61, 030	-----	51, 351	112, 381	57, 254	1. 066	. 897	1. 963
West Virginia.....	1, 163, 170	-----	33, 041	1, 196, 211	642, 161	1. 811	. 052	1. 863
Undistributed ¹	1, 054, 607	141, 484	59, 298	1, 255, 389	609, 879	1. 961	. 097	2. 058
	63, 795, 555	2, 625, 620	6, 026, 785	72, 447, 960	37, 410, 897	1. 776	. 161	1. 937

¹ Includes Colorado, Massachusetts, and Wisconsin.

Iron ore and other metallic materials consumed and pig iron produced in the United States, 1919-1928, in gross tons

Year	Metalliferous materials consumed				Pig iron produced, exclusive of ferro-alloys	Materials consumed per ton of iron made			
	Iron and manganiferous iron ores		Cinder, scale, and scrap	Total		Ores		Cinder, scale, and scrap	Total
	Domestic	Foreign				Domestic	Foreign		
1919-----	54, 950, 623	520, 785	3, 721, 448	59, 192, 856	30, 508, 122	1. 801	0. 017	0. 122	1. 940
1920-----	64, 671, 894	968, 313	5, 650, 128	71, 290, 335	36, 242, 748	1. 784	. 027	. 156	1. 967
1921-----	28, 847, 395	372, 038	2, 269, 864	31, 489, 297	16, 403, 627	1. 759	. 023	. 138	1. 920
1922-----	46, 485, 690	910, 205	4, 285, 187	51, 681, 082	26, 826, 210	1. 733	. 034	. 160	1. 927
1923-----	69, 272, 579	2, 084, 094	5, 376, 448	76, 733, 121	39, 767, 482	1. 742	. 052	. 135	1. 929
1924-----	51, 880, 562	2, 012, 689	4, 646, 320	58, 539, 571	30, 869, 199	1. 681	. 065	. 150	1. 896
1925-----	62, 029, 734	2, 337, 767	5, 137, 068	69, 504, 569	36, 124, 678	1. 717	. 065	. 142	1. 924
1926-----	65, 922, 601	2, 442, 631	6, 254, 523	74, 619, 755	38, 755, 698	1. 701	. 063	. 161	1. 925
1927-----	61, 718, 383	2, 540, 558	5, 602, 006	69, 860, 947	35, 875, 129	1. 720	. 071	. 156	1. 947
1928-----	63, 795, 555	2, 625, 620	6, 026, 785	72, 447, 960	37, 410, 897	1. 706	. 070	. 161	1. 937

Foreign iron and manganiferous iron ores consumed in the manufacture of pig iron in the United States, 1927 and 1928, by sources of ore, in gross tons

Source of ore	1927	1928	Source of ore	1927	1928
Africa.....	379, 494	385, 362	France.....	5, 643	-----
Asia.....	-----	1, 687	Newfoundland.....	74, 445	51, 080
Australia.....	-----	13, 314	Spain.....	101, 393	39, 660
Brazil.....	875	126	Sweden.....	233, 027	128, 889
Canada.....	3, 094	-----	Undistributed.....	135, 012	70, 997
Chile.....	1, 186, 904	1, 525, 846			
Cuba.....	420, 671	408, 659		2, 540, 558	2, 625, 620

LAKE SUPERIOR DISTRICT

PRODUCTION

The total quantity of iron ore mined in the Lake Superior district, not including the Iron Ridge area in Wisconsin, increased 2 per cent in 1928. The output of the several ranges is shown in the table that follows. After 1905 the figures do not include manganiferous iron ore containing 5 per cent or more of manganese; 1,077,705 gross tons of this ore was mined in 1928, compared with 1,300,084 tons in 1927. The Mesabi range produced 66 per cent of the iron-ore output of the Lake Superior district and 56 per cent of the total output of the United States in 1928. The proportion contributed by this range has been remarkably uniform since 1915 but was slightly more than the average in 1928. Production increased on the Cuyuna, Mesabi, and Vermilion iron ranges; the increase on the Cuyuna range was the largest, and that on the Vermilion range was the smallest.

Iron ore mined in the Lake Superior district, 1854-1928, in gross tons

[Exclusive after 1905 of ore containing 5 per cent or more of manganese]

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854-1870.....	3,971,716						3,971,756
1871-1880.....	10,294,047	858,810					11,152,871
1881-1890.....	18,598,012	11,917,416	8,657,807	3,260,426			42,433,661
1891-1900.....	27,269,545	21,639,872	23,361,043	12,097,048	32,282,873		116,650,381
1901-1910.....	37,728,143	41,974,789	34,514,899	15,350,581	194,654,902		324,223,314
1911-1915.....	18,404,620	21,862,454	21,366,821	7,234,387	142,721,213	3,191,627	214,781,122
1916.....	4,792,987	6,649,578	7,707,101	1,704,440	41,325,341	1,555,641	63,735,088
1917.....	4,638,374	6,366,483	7,881,232	1,481,301	41,127,323	1,986,608	63,481,321
1918.....	3,946,554	6,041,637	7,837,634	1,192,677	39,055,977	1,705,315	59,779,794
1919.....	4,158,751	4,863,968	7,368,994	1,051,795	33,262,954	1,685,877	52,392,339
1920.....	4,457,609	5,651,542	8,298,206	1,053,518	36,641,880	1,757,775	57,860,530
1921.....	2,204,114	2,147,669	3,135,477	981,576	16,380,190	449,559	25,298,485
1922.....	2,745,626	3,290,641	4,910,789	1,108,764	26,704,601	953,595	39,716,016
1923.....	3,910,909	4,913,541	6,112,662	1,119,113	41,809,018	1,420,165	59,285,408
1924.....	3,579,087	3,780,664	5,579,883	1,141,690	29,818,965	941,430	44,841,719
1925.....	3,813,687	5,009,022	6,377,710	1,331,753	34,851,109	673,382	52,056,663
1926.....	4,046,191	5,445,683	6,949,920	1,568,953	37,997,797	1,134,863	57,143,407
1927.....	4,015,730	5,458,182	6,604,830	1,577,817	32,866,034	1,017,287	51,539,880
1928.....	3,755,343	4,855,735	6,342,092	1,628,289	34,856,333	1,079,383	52,517,175
	166,331,045	162,727,586	173,007,100	54,884,128	816,356,510	19,554,507	1,392,860,876

SHIPMENTS AND RECEIPTS

According to the Lake Superior Iron Ore Association, a total of 54,855,641 gross tons of iron ore and manganiferous iron ore was shipped in 1928 from the Lake Superior district, including the Iron Ridge area in Wisconsin, as compared with 52,344,099 tons in 1927. The shipments, as reported to the Bureau of Mines by producers, amounted to 53,768,733 gross tons of iron ore and 1,077,705 tons of manganiferous iron ore containing 5 per cent or more of manganese, a total of 54,846,438 tons in 1928, as compared with 51,038,403 tons of iron ore and 1,300,084 tons of manganiferous iron ore, a total of 52,338,487 tons in 1927.

The iron ore received at Lake Erie ports, according to the Marine Review, amounted to 36,956,342 gross tons and at Lake Michigan ports to 14,269,383 gross tons, a total of 51,225,725 tons in 1928, compared with 36,552,791 tons at Lake Erie ports and 12,112,634 tons

at Lake Michigan ports, a total of 48,665,425 tons in 1927. Detailed figures of shipments and receipts by ports and by months for recent years may be found in the Marine Review.

STOCKS OF ORE AT LAKE ERIE PORTS

Stocks of iron ore at lower Lake ports at the end of the shipping season are important because of their bearing on the manufacture of pig iron during the following winter and spring. According to the Marine Review, at the close of navigation in 1928, 6,454,126 gross tons of ore was in stock at Lake Erie ports, compared with 6,944,315 tons on the corresponding date in 1927. At the opening of navigation in May, 1929, 3,646,546 tons of ore was in stock at these ports, indicating a withdrawal of 2,807,580 tons during the winter of 1928-29. The average quantity withdrawn each winter during the preceding five winters was about 3,141,000 tons. Detailed statistics concerning these stocks by ports may be found in the Marine Review.

PRICES OF LAKE SUPERIOR ORE

The price of iron ore per unit of iron in the natural state for the four standard grades of Lake Superior ore for the last 15 years is shown in the Iron Trade Review.⁵ The base of Bessemer ore, old-range and Mesabi, for 1925 to 1928 is a metallic iron content of 51.5 per cent, natural, instead of 55 per cent as for 1924 and many earlier years. The base of non-Bessemer ore, old-range and Mesabi, remains as heretofore at 51.5 per cent, natural. The unit prices established April 16, 1928, the same as those obtaining in 1925 to 1927, are as follows: Old-range Bessemer, 8.835 cents; Mesabi Bessemer, 8.544 cents; old-range non-Bessemer, 8.544 cents; and Mesabi non-Bessemer, 8.252 cents. The prices per ton that correspond to these unit prices are, respectively, \$4.55, \$4.40, \$4.40, and \$4.25. The prices for 1925 to 1928 are the lowest that have been in effect since the season of 1916. The lowest prices ever quoted for these ores were \$2.60 for old-range Bessemer in 1897, \$2.15 for Mesabi Bessemer in 1895, \$1.85 for old-range non-Bessemer in 1898, and \$1.75 for Mesabi non-Bessemer in 1898.

IRON-ORE RESERVES

Estimates of ore reserves for Minnesota, furnished by the Minnesota Tax Commission, and for Michigan, furnished by the Michigan Board of State Tax Commissioners, cover developed and prospective ore in the ground and ore in stock piles. These estimates show decreases from the previous year of about 4,601,000 gross tons in Minnesota and about 4,223,000 tons in Michigan.

Iron-ore reserves in Minnesota May 1, 1924-1928, in gross tons

Range	1924	1925	1926	1927	1928
Mesabi.....	1, 275, 347, 126	1, 250, 086, 347	1, 233, 979, 351	1, 201, 054, 119	1, 190, 480, 901
Vermilion.....	13, 169, 953	13, 539, 256	12, 382, 725	12, 126, 490	14, 483, 285
Cuyuna.....	46, 121, 021	52, 124, 561	51, 090, 529	49, 652, 592	53, 268, 438
	1, 334, 638, 100	1, 315, 750, 164	1, 297, 452, 605	1, 262, 833, 201	1, 258, 232, 624

⁵ Iron Trade Review, Apr. 19, 1928, p. 1040.

Iron-ore reserves in Michigan January 1, 1925-1929, in gross tons

Range	1925	1926	1927	1928	1929
Gogebic.....	51,646,890	52,131,121	53,342,720	48,681,075	48,587,126
Marquette.....	68,978,647	67,160,777	63,612,812	60,219,781	57,920,862
Menominee (including Iron River and Cryst- al Falls districts).....	67,184,024	69,188,118	67,103,492	64,752,677	62,922,419
	187,809,561	188,480,016	184,059,024	173,653,533	169,430,407

IRON-ORE MINING, BY STATES

LAKE SUPERIOR DISTRICT

The outstanding features of mining developments in the Lake Superior iron mining district are described in articles published in trade and mining journals.⁶

Michigan.—Mining activity on the Michigan iron ranges in 1928 was on a considerably reduced scale, as is shown by a production of 13,676,984 gross tons, compared with 15,075,079 tons in 1927. The production in 1928 was made by 64 mines in 5 counties, as the following table shows.

Iron ore mined in Michigan, 1927 and 1928, by counties

County	1927		1928	
	Active mines	Gross tons	Active mines	Gross ton
Baraga.....	1	107,017	1	89,996
Dickinson.....	5	1,120,579	5	1,181,724
Gogebic.....	19	5,601,167	17	5,065,906
Iron.....	24	4,337,603	23	3,674,011
Marquette.....	21	3,908,713	18	3,665,347
	70	15,075,079	64	13,676,984

The ore reserves in Michigan on January 1, 1929, amounted to 169,430,407 gross tons, a decrease from the previous year of about 4,223,000 gross tons—evidence that new discoveries did not keep pace with production.

Only one mine in Michigan, the Norrie group in Gogebic County, produced more than 1,000,000 tons in 1928. Of the 64 active mines in Michigan in 1928, 45 yielded more than 100,000 tons each. The average production per mine in Michigan in 1928 was 213,703 tons, compared with 215,358 tons in 1927.

A report on the iron-ore mines of Michigan for 1928, published by the geological survey division of the Michigan Department of Conservation,⁷ shows that the average number of men employed per day was 9,206, the average number of days worked underground and in open pits was 247, the average daily wage was \$4.704, the

⁶ Hain, A. J., Concentration, in Ore and Ownership, is Trend at Iron Mines: Iron Trade Rev., vol. 84, Jan. 3, 1929, pp. 36-39; Skillings' Mining Review (various issues).

⁷ Pardee, F. G., and Osgood, W., General Statistics Covering Costs and Production of Michigan Iron Mines: Geological Survey Division, Department of Conservation (Lansing), 1929.

average yearly earning was \$1,161.80, and the tons of ore mined per man per day was 5.26.

The following table on average per ton costs of mining iron ore at underground mines and at siliceous open pits has been condensed from statistics published in much greater detail by the geological survey division of the Michigan Department of Conservation.

Average per ton costs of mining iron ore at underground mines and at siliceous open pits in Michigan in 1928

Item	Underground					Siliceous open pits
	Dickinson	Gogebic	Iron	Marquette	Total	
Cost of mining.....	\$1. 8947	\$1. 6119	\$1. 2451	\$1. 7316	\$1. 5528	\$0. 4323
Deferred mining costs.....	. 0145	. 1274	. 1169	. 0827	. 1014	. 0629
Taxes.....	. 2224	. 3313	. 1885	. 2813	. 2618	. 0603
General overhead.....	. 1673	. 2436	. 2304	. 2827	. 2414	. 1699
Transportation.....	1. 4553	1. 6595	1. 4667	1. 4014	1. 5211	1. 4084
Marketing.....	. 0439	. 0302	. 0716	. 0926	. 0607	. 0880
Total ore cost.....	3. 7981	4. 0039	3. 3192	3. 8723	3. 7392	2. 2218
Lake Erie value per ton.....	4. 3354	4. 5872	4. 0336	4. 5685	4. 3959	2. 2094
Gross ore profit ¹	. 5373	. 5833	. 7144	. 6962	. 6567	-. 0124

¹ This figure does not represent true profit, as much ore is sold at a discount.

The mining methods used in a large mine producing hard specular ore on the Marquette range of Michigan are described by Eaton,⁸ who also gives detailed figures on the cost of mining the ore. Eaton states:

Although the conditions of mining are unique in this district, they are similar to those in many other districts, and information in regard to the methods used and the results obtained should be of interest. The methods now used are an outgrowth of those of former years which have been adapted to conform with improvements in mechanical appliances, changes in the wage scale and labor supply, and the selling price of the product.

Minnesota.—Mining activities in Minnesota were on an increased scale in 1928, the production of 37,564,005 gross tons representing an increase of 6 per cent over 1927. The output in 1928 was made by 84 mines in 3 counties, as shown by the following table.

Iron ore mined in Minnesota, 1927 and 1928, by counties

County	1927		1928	
	Active mines	Gross tons	Active mines	Gross tons
Crow Wing.....	7	1, 017, 287	8	1, 079, 383
Itasca.....	20	6, 467, 507	19	6, 919, 959
St. Louis.....	68	27, 976, 344	57	29, 564, 663
	95	35, 461, 138	84	37, 564, 005

⁸ Eaton, Lucien, *Method and Cost of Mining Hard Specular Hematite on the Marquette Range, Michigan*: Inf. Circ. 6138, Bureau of Mines, May, 1929, 14 pp.

The reserves of iron ore in Minnesota on May 1, 1928, amounted to 1,258,232,624 gross tons, a decrease of 4,600,600 tons from the previous year, indicating that new ore discovered during the year apparently was not enough to keep pace with production.

The largest producing mine in Minnesota, as well as in the United States, in 1928 was the Missabe Mountain, an open-pit operation in St. Louis County, which yielded 5,255,987 gross tons. The Hull-Rust mine, also an open-pit operation in St. Louis County, which had been the leading producer of iron ore in the United States for a number of years prior to 1926 and which ranked second and third, respectively, in 1926 and 1927, yielded only 1,885,200 tons in 1928 and dropped to fifth place. Of the 84 active mines in Minnesota in 1928, 63 yielded more than 100,000 tons each. The average production per mine in Minnesota in 1928 was 447,191 tons, compared with 373,275 tons in 1927.

Wisconsin.—The production of iron ore in Wisconsin in 1928 was 1,284,592 gross tons, an increase of 18 per cent over 1927. This output was made by six mines in two counties, as shown by the following table.

Iron ore mined in Wisconsin, 1927 and 1928, by counties

County	1927		1928	
	Active mines	Gross tons	Active mines	Gross tons
Dodge.....	2	87,455	2	8,406
Iron.....	4	1,003,663	4	1,276,186
	6	1,091,118	6	1,284,592

The chief producing mine in Wisconsin in 1928, as in 1927, was the Montreal No. 4 mine in Iron County, which yielded 452,782 gross tons. Of the 6 active mines in Wisconsin in 1928, 4 yielded more than 100,000 tons each.

Iron-ore analyses.—The iron content of the ore shipped from the Lake Superior district in 1928 averaged 51.15 per cent, natural, compared with 51.19 per cent in 1927, showing how closely these ores are graded. The average iron content in 1928, however, is the lowest since 1902, the year in which average analyses were first compiled. The percentage of manganese increased slightly, and the percentages of silica and phosphorus decreased.

The following table, compiled by the Lake Superior Iron Ore Association, summarizes the average analyses of the total tonnages of all grades of ore shipped and shows the remarkable uniformity maintained during the last 10 years.

Average analyses of total tonnages of all grades of iron ore from all ranges of Lake Superior district, 1919-1928

Year	Gross tons	Fe (natural)	P	SiO ₂	Mn	Moisture
		<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
1919.....	46,666,878	51.57	0.105	8.04	0.73	11.34
1920.....	57,938,428	51.69	.103	8.13	.77	11.09
1921.....	22,523,989	52.07	.087	8.23	.62	10.95
1922.....	43,431,294	51.87	.099	8.23	.76	10.78
1923.....	60,024,176	51.79	.095	8.22	.79	10.76
1924.....	43,276,165	51.72	.100	8.45	.76	10.75
1925.....	54,784,355	51.74	.099	8.42	.82	10.58
1926.....	59,151,368	51.75	.101	8.35	.80	10.78
1927.....	51,730,711	51.19	.105	8.60	.84	11.31
1928.....	54,045,941	51.15	.099	8.43	.85	11.37

During this 10-year period the iron content ranged from 51.15 to 52.07 per cent, the phosphorus from 0.087 to 0.105 per cent, the silica from 8.04 to 8.6 per cent, the manganese from 0.62 to 0.85 per cent, and the moisture from 10.58 to 11.37 per cent. This uniformity does not, of course, indicate that the average grade of the available Lake Superior iron ore is not declining. The grade of shipments has been maintained by methods of beneficiation, which are ever becoming more elaborate, and by mixing ores from different deposits.

SOUTHEASTERN STATES

Alabama.—The production of iron ore in Alabama in 1928 amounted to 6,307,844 gross tons, a decrease of 2 per cent from 1927. This output was made by 24 mines in 8 counties, as the following table shows.

Iron ore mined in Alabama, 1927 and 1928, by counties

County	1927		1928	
	Active mines	Gross tons	Active mines	Gross tons
Blount.....	5	197,446	5	247,255
Etowah.....	1	1,978	1	10,472
Franklin.....	1	128,088	1	104,858
Jefferson.....	7	5,857,326	6	5,658,021
Tuscaloosa.....	5	240,041	5	261,918
Calhoun.....	1	20,585	2	25,320
Cherokee.....	1		3	
Talladega.....	2		1	
	23	6,445,464	24	6,307,844

The ore produced in Blount County in 1928 was brown ore, all of which was washed; the iron content of the concentrates averaged 50 per cent, the manganese averaged 0.75 per cent, and the phosphorus averaged 0.3 per cent. The ore produced in Talladega County averaged about 53 per cent of iron. The brown-ore concentrates from the Russellville district in Franklin County averaged 49 per cent of iron. Tuscaloosa County was the largest producer of brown ore in Alabama in 1928; the iron content of the concentrates ranged from 44.49 to 47.42 per cent and averaged 45.62 per cent.

Most of the ore mined in Alabama is hematite, much of which is self-fluxing or nearly so. Jefferson County is the chief producer of hematite; the iron content of that shipped in 1928 ranged from 32.98 to 37.18 per cent, natural, and averaged 36.56 per cent.

The self-fluxing iron ores of Alabama are at present the foundation of the iron and steel industry in that State; in addition, there are seams containing practically the same percentages of iron but too much silica. These siliceous ores are now valueless, but if they could be concentrated by reducing the silica content the ore reserves of the Birmingham district would be greatly augmented. In forwarding its mineral-conservation policies the United States Bureau of Mines has given some attention to the siliceous ores of this district, and a report on the gravity concentration of the oolitic iron ores has been published.⁹ The results of this study are summarized in the report, as follows:

1. The problem of the concentration of the low-grade oolitic siliceous iron ores of Alabama has been reconsidered, and a method less expensive than the one formerly described by the bureau has been worked out for certain ores.

2. The lean ore consists of relatively large, rounded quartz grains and smaller hematite grains held together by a hematite cement.

3. The siliceous oolitic grains may be shelled out of the ore matrix in a rod mill, using a special type of grinding media consisting of rubber-covered iron rods to disintegrate the ore into its component minerals.

4. After liberating the grains, the quartz oolites may be rejected by gravity concentration with tables. The hematite is reclaimed as clean slime and as table concentrate.

5. Tests have been made to determine a practical flow sheet, the degree of concentration, and possible recovery.

6. A typical unit or section for a concentration plant has been outlined, which would treat 12 tons of ore per hour. The unit would consist of a rod mill using rubber-covered rods, a drag deslimmer, a 10-spigot classifier, and 10 tables. A certain test indicated that 12 tons per hour of mill feed will give 8.7 tons of concentrate, containing 47.6 per cent iron, 14.2 per cent silica, and 5.5 per cent lime. A cost of treating would be about 40 cents per ton of ore milled.

7. On the five ores examined the scheme worked successfully on four of them; one sample contained slate, which defeated the process.

Georgia.—The production of iron ore in Georgia in 1928 was 73,052 gross tons, an increase of 45 per cent over 1927. This output was made by four mines in two counties, as shown by the following table.

Iron ore mined in Georgia, 1927 and 1928, by counties

County	1927		1928	
	Active mines	Gross tons	Active mines	Gross tons
Bartow.....	1	9,305	1	11,130
Polk.....	4	41,007	3	61,922
	5	50,312	4	73,052

⁹ De Vaney, F. D., Gandrud, B. W., and Coghill, W. H., Gravity Concentration of Alabama Oolitic Iron Ores: Repts. of Investigations, Serial 2937, Bureau of Mines, May, 1929, 7 pp.

All the ore from Georgia in 1928 was washed brown ore; the iron content of the concentrates averaged about 50 per cent. Most of this ore was mined from the Cedartown area in Polk County; the remainder was from the Cartersville district in Bartow County.

Tennessee.—Tennessee yielded both hematite and brown ore in 1928; the total mined was 128,928 tons, an increase of 6 per cent over 1927. This output was made by 6 mines in 5 counties, as shown by the following table.

Iron ore mined in Tennessee, 1927 and 1928, by counties

County	1927		1928	
	Active mines	Gross tons	Active mines	Gross tons
Dickson.....	1	8,552	2	8,898
Hickman.....	1	22,047	1	23,095
Lawrence.....	1	3,942	1	13,273
Hamilton.....	1	87,373	1	83,662
Roane.....	2		1	
	6	121,914	6	128,928

By far the greater part of the ore is hematite, mined near Rockwood, Roane County. The iron content of the Rockwood ore averaged 34 per cent, natural, in 1928. The brown ore mined in 1928 was chiefly from the Johnson mine, in Hickman County, the Iron Hill mine in Dickson County, and the Van Leer mine in Lawrence County. The brown ore from these mines is hand picked, washed, and jigged, and the iron content of the concentrates recovered in 1928 averaged 48, 49, and 46.74 per cent, respectively. A small quantity of hematite used for paint was mined at a deposit near Ooltewah, Hamilton County, in 1928.

In 1928, 85,496 gross tons of iron sinter, recovered from copper sulphide ore mined in Polk County, was shipped; the sinter shipped in 1928 averaged 64.74 per cent of iron, 0.14 per cent of manganese, and 0.06 per cent of phosphorus. These shipments are not included in the statistics of iron ore.

Virginia.—The production of iron ore in Virginia in 1928 was 27,902 gross tons, a decrease of 57 per cent from 1927. This output consisted of 23,287 tons of hematite averaging 41 per cent of iron, natural, from the Cloverdale mine in Botetourt County and 4,615 tons of brown ore concentrates averaging 49 per cent of iron from the Porter mine in Wythe County. A little ore from stock pile at the Oriskany mine in Botetourt County was shipped for experimental purposes.

MISSOURI

The output of iron ore in Missouri in 1928 amounted to 94,899 gross tons, an increase of 21 per cent over 1927. The output in 1928 consisted of 25,000 tons of hematite averaging about 51 per cent of iron, natural, from the Rueppel mine in Franklin County and 69,899 tons of hematite concentrates averaging 49.42 per cent of iron from the Iron Mountain mine in St. Francois County. The ore from these mines in 1928 was shipped to the blast furnaces at

Granite City, Ill. The Missouri production, however, was not enough to meet the requirements of these furnaces, the larger part of the ore they consumed being obtained from the Lake Superior district.

NORTHEASTERN STATES

New Jersey.—The production of iron ore in New Jersey in 1928 was 250,332 gross tons, an increase of 13 per cent over 1927. The Mt. Hope mine, near Wharton, Morris County, with an output of 151,651 tons of concentrates, was again the largest producer; the iron content of the magnetite concentrates shipped averaged 60.83 per cent. The Richard mine, also near Wharton, Morris County, produced 81,065 tons of magnetite concentrates and 770 tons of lump ore; the concentrates shipped averaged 61.54 per cent of iron. All magnetite concentrates in the stock pile at the Cannon and Peters mines near Ringwood Manor, Passaic County, were shipped during 1928, and some ore from stock pile at the Ahles mine near Buttzville, Warren County, was sold for use in gas purification and in the manufacture of paint and a little was sold for use in making pig iron. The Beach Glen mine, near Rockaway, Morris County, inactive from 1924 to 1927, produced 16,846 tons of magnetite concentrates in 1928, which averaged 61 per cent of iron.

New York.—The production of iron ore in New York in 1928, amounting to 712,757 gross tons, was 16 per cent less than that in 1927. Operations at the Harmony and Old Bed mines at Mineville, in Essex County, were on a slightly increased scale in 1928; the mines were the largest producers of magnetite in the State. Practically all the ore from these mines is sintered; the iron content averages about 64 per cent. A detailed description of the mining method used and of the results obtained in the exploitation of the bedded magnetite deposits of the Mineville district, as well as a computation of mining costs at the Old Bed and Harmony mines, is given by Cummings.¹⁰ The Chateaugay mine in Clinton County was worked on a greatly reduced scale in 1928; all the ore from this mine is sintered; the sinter shipped in 1928 averaged 62.5 per cent of iron and 0.005 per cent of phosphorus. The Forest of Dean mine in Orange County yielded about 36 per cent less magnetite concentrates in 1928 than in 1927; the concentrates shipped in 1928 averaged about 62 per cent of iron. The Forest of Dean mine has been described by Keiser¹¹ and by Skillings.¹² The No. 21 mine in Essex County was nonproductive again in 1928, but considerable magnetite concentrates that averaged about 60 per cent of iron were shipped from stock pile. New York is the largest producer of iron ore for use in paint. This ore, known as Clinton hematite, was mined in 1928 in Oneida and Wayne Counties.

Pennsylvania.—Pennsylvania, the largest producer of magnetite in the United States, yielded 1,023,870 gross tons of ore in 1928, a decrease of 13 per cent from 1927. The chief producing mine in Pennsylvania is the Cornwall mine in Lebanon County, which

¹⁰ Cummings, A. M., Method and Cost of Mining Magnetite in the Mineville District, New York: Inf. Circ. 6092, Bureau of Mines, December, 1928, 12 pp.

¹¹ Keiser, H. D., The Forest of Dean Mine: Eng. and Min. Jour., vol. 127, June 1, 1929, pp. 872-875.

¹² Skillings, D. N., Forest of Dean Iron Mine: Skillings' Min. Rev., vol. 17, Dec. 22, 1928, pp. 1, 6.

yielded 975,377 tons in 1928. The ore from the Cornwall mine was shipped to Lebanon, Pa., where it was concentrated and sintered before being charged to the blast furnaces. The crude ore shipped from the Cornwall mine to Lebanon in 1928 averaged 41.82 per cent of iron, natural, whereas the iron content of the concentrated ore averaged 57.74 per cent. The magnetite from the French Creek mine, near St. Peters, Chester County, was shipped to Birdsboro, Pa., where it was sintered; the iron content of the sinter made in 1928 averaged 57.59 per cent. The ore in the French Creek mine is reported to have been exhausted during 1928. Some carbonate ore for use in paint was mined in Carbon County in 1928.

WESTERN STATES

Colorado.—The production of brown iron ore in Colorado in 1928 was 52,713 gross tons, an increase of 64 per cent over 1927. This ore was mined at the Orient mine in Saguache County and averaged, natural, 42.6 per cent of iron, 1.46 per cent of manganese, and 0.02 per cent of phosphorus.

New Mexico.—The production of iron ore, all magnetite, in New Mexico in 1928 was 184,623 gross tons, 14 per cent less than that in 1927. The ore mined in New Mexico in 1928 was from the Union Hill mine near Fierro, Grant County, and averaged, natural, 51 per cent of iron, 0.9 per cent of manganese, and 0.08 per cent of phosphorus. A magnetic cobbing plant to treat the ore from the Union Hill mine was installed during 1928.

Utah.—The production of iron ore in Utah in 1928, amounting to 320,655 gross tons, was 44 per cent more than that in 1927. All the ore produced in Utah in 1928 was hematite from the Desert Mound mine near Iron Springs, Iron County; it averaged, dried, 52.63 per cent of iron and 0.35 per cent of phosphorus.

Wyoming.—The production of iron ore in Wyoming in 1928 amounted to 491,280 gross tons, a decrease of 19 per cent from 1927. The output was from the Sunrise mine in Platte County. The ore is hematite; that shipped in 1928 averaged, natural, 55.2 per cent of iron, 0.16 per cent of manganese, and 0.044 per cent of phosphorus.

FOREIGN TRADE IN IRON ORE

IMPORTS AND EXPORTS

The iron ore imported into the United States in 1928 amounted to 2,452,646 gross tons, valued at \$5,428,019, or \$2.21 a ton, as compared with 2,620,717 tons, valued at \$6,068,283, or \$2.32 a ton, in 1927. These figures represent a decrease of 6 per cent in quantity and 11 per cent in total value as compared with 1927. Africa, Chile, and Cuba were the chief sources of imports in 1928; these three countries furnished 92 per cent of the total. The other main sources of imported ore in 1928 were Brazil, Newfoundland and Labrador, Spain, and Sweden; 5 per cent of the total came from these countries.

Iron ore imported into the United States, 1926-1928, by countries

Country	1926		1927		1928	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Africa:						
British West.....			1, 860	\$23, 715		
French—						
Algeria and Tunisia.....	320, 134	\$997, 592	445, 070	1, 419, 410	459, 860	\$1, 550, 643
Morocco.....	5, 540	20, 000				
Other.....	1, 611	20, 943	1, 350	17, 955		
Australia.....			5, 000	14, 381	18, 115	58, 516
Belgium.....	55	139				
Brazil.....	3, 708	53, 447	8, 905	69, 261	31, 805	229, 159
Canada.....	16, 984	59, 831	26, 079	96, 392	13, 309	44, 623
Chile.....	1, 364, 400	1, 561, 303	1, 369, 200	1, 560, 764	1, 434, 860	1, 579, 119
Costa Rica.....					(1)	10
Cuba.....	539, 000	2, 005, 112	392, 113	1, 499, 020	369, 286	1, 416, 561
Egypt.....	6, 550	36, 555	10, 420	28, 141	14, 080	89, 964
France.....	8, 279	64, 866			30	206
Germany.....	10, 6 40	40, 888	2, 274	8, 369	2, 523	8, 384
Italy.....	2 0	318	7, 700	10, 305		
Jamaica.....					81	1, 620
Japan.....					6	133
Netherlands.....			538	1, 881		
Newfoundland and Labrador.....	119, 544	455, 188	61, 030	240, 199	37, 048	144, 595
Norway.....	18, 313	65, 167	16, 608	70, 720		
Persia.....					1, 750	31, 936
Portugal.....	900	14, 856				
Soviet Russia in Europe.....					(1)	2
Spain.....	83, 608	235, 636	27, 165	72, 701	37, 420	134, 113
Sweden.....	53, 605	214, 917	244, 458	912, 341	26, 558	107, 773
Turkey in Europe.....	445	1, 187				
United Kingdom.....	105	4, 371	947	22, 728	5, 915	30, 662
Virgin Islands of the United States.....	2, 000	24, 000				
	2, 555, 441	5, 876, 316	2, 620, 717	6, 068, 283	2, 452, 646	5, 428, 019

¹ Less than 1 ton.

Iron ore imported into the United States, 1872-1928, in gross tons

1872-1880.....	1, 188, 267	1921.....	315, 768
1881-1890.....	7, 663, 630	1922.....	1, 135, 156
1891-1900.....	5, 869, 757	1923.....	2, 768, 430
1901-1910.....	11, 798, 568	1924.....	2, 047, 055
1911-1915.....	9, 202, 947	1925.....	2, 190, 697
1916.....	1, 325, 736	1926.....	2, 555, 441
1917.....	971, 663	1927.....	2, 620, 717
1918.....	787, 468	1928.....	2, 452, 646
1919.....	476, 461		
1920.....	1, 273, 456		56, 643, 863

Exports of iron ore from the United States in 1928 amounted to 1,282,306 gross tons, valued at \$4,797,881, or \$3.74 a ton, as compared with 898,793 tons, valued at \$3,425,435, or \$3.81 a ton, in 1927. These figures represent an increase in 1928 of 43 per cent in quantity and 40 per cent in total value. Of the ore exported in 1928 more than 97 per cent went to Canada; the remainder went to the United Kingdom.

Iron ore exported from the United States, 1927 and 1928, by countries

Country	1927		1928	
	Gross tons	Value	Gross tons	Value
Argentina.....	20	\$549		
Canada.....	887, 049	3, 365, 967	1, 250, 206	\$4, 656, 611
Norway.....	3	14		
Trinidad and Tobago.....	25	425		
United Kingdom.....	11, 696	58, 480	32, 100	141, 270
	898, 793	3, 425, 435	1, 282, 306	4, 797, 881

Iron ore exported from the United States, 1899-1928, in gross tons

1899-1900-----	92, 125	1922-----	602, 194
1901-1910-----	2, 713, 397	1923-----	1, 116, 932
1911-1915-----	4, 265, 538	1924-----	595, 413
1916-----	1, 183, 952	1925-----	630, 521
1917-----	1, 132, 313	1926-----	868, 710
1918-----	1, 256, 383	1927-----	898, 793
1919-----	996, 569	1928-----	1, 282, 306
1920-----	1, 145, 037		
1921-----	440, 106		19, 220, 289

IRON-ORE MINING IN CUBA

The iron ore shipped from Cuba to the United States in 1928 amounted to 394,420 gross tons, as compared with 414,847 tons in 1927, a decrease of 5 per cent. The shipments in 1928 were 86 per cent of hematite, including a little magnetite, from the Daiquiri and Juragua mines on the southern coast and 14 per cent of brown ore from the Mayari mines near the northern coast. In 1928 the hematite, dried at 212° F., contained 55.32 per cent of iron, whereas the brown ore, nodulized, carried 54.86 per cent. In 1927 the hematite, dried, averaged 59.55 per cent, whereas the brown ore, nodulized, averaged 55.74 per cent.

The total stock of ore, natural and nodulized, reported on hand at the end of 1928 was 822,200 gross tons, compared with 782,918 tons at the end of 1927, an increase of 5 per cent.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The statistics of the shipments of Cuban iron ore are collected by the Bureau of Mines.

Iron ore shipped from mines in the Province of Oriente, Cuba, 1884-1928, in gross tons

Year	Juragua (hematite and mag- netite)	Sigua (hematite)	Daiquiri (hematite and a little magnetite)	Mayari (brown ore)	Guamá (hematite)	El Cuero (hematite)	Total
1884-1890-----	1, 142, 519						1, 142, 519
1891-1900-----	¹ 2, 348, 473	20, 438	² 979, 992				3, 348, 903
1901-1910-----	2, 104, 186		³ 4, 456, 440	307, 700	41, 211	224, 729	7, 134, 296
1911-1915-----	1, 567, 112		1, 837, 669	1, 855, 525		532, 194	5, 792, 500
1916-----	212, 013		181, 602	258, 451		60, 650	712, 716
1917-----	39, 784		181, 028	287, 904		44, 769	553, 485
1918-----	17, 128		353, 103	232, 540		40, 761	643, 532
1919-----			279, 700	78, 080			357, 780
1920-----	(⁴)		⁴ 561, 268	321, 515			882, 783
1921-----	(⁴)		⁴ 130, 359				130, 359
1922-----	(⁴)		⁴ 444, 794				444, 794
1923-----	(⁴)		⁴ 674, 371				674, 371
1924-----	(⁴)		⁴ 283, 094	11, 461			294, 555
1925-----	(⁴)		⁴ 514, 040	44, 127			558, 167
1926-----	(⁴)		⁴ 528, 647	49, 444			578, 091
1927-----	(⁴)		⁴ 348, 607	66, 240			414, 847
1928-----	(⁴)		⁴ 340, 404	54, 016			394, 420
	⁴ 7, 431, 215	20, 438	⁴ 12, 095, 113	3, 567, 003	41, 241	903, 103	24, 058, 118

¹ Of this quantity, 5,932 tons was sent to Pictou, Nova Scotia.

² Of this quantity, 51,537 tons was sent to ports outside of the United States.

³ Of this quantity, 12,691 tons was sent to ports outside of the United States.

⁴ Shipments of Juragua mines, 1920-1928, included with Daiquiri mines.

WORLD PRODUCTION OF IRON ORE, BY COUNTRIES

The following table shows the production of iron ore by countries for 1924 to 1928, so far as figures are obtainable. Figures for preceding years appear in earlier volumes of Mineral Resources. Com-

plete returns for 1928 are not available, but those for 1927 and earlier years are fairly complete. Thus, the figures for 1927 indicate a total world production of about 170,000,000 metric tons, of which the United States furnished about 37 per cent. In 1926 the United States contributed about 45 per cent of the world total, which apparently was about 154,000,000 metric tons.

Iron ore produced, 1924-1928, by countries, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924	1925	1926	1927	1928
North America:					
Canada ^{1 2}	1,343	3,609	181		(³)
Cuba ¹	299,283	567,126	587,369	421,505	400,750
Mexico	52,448	127,492	92,982	(³)	(³)
Newfoundland ⁴	992,972	1,150,169	879,603	1,356,851	1,572,725
United States	55,138,411	62,901,620	68,708,349	62,732,045	63,195,351
South America:					
Brazil ⁵		30,000	30,000	30,000	30,000
Chile ⁶	987,969	1,350,834	1,476,355	1,516,440	1,515,203
Europe:					
Austria	713,805	1,030,364	1,094,372	1,598,570	1,928,182
Belgium	154,970	165,650	144,980	180,890	(³)
Bulgaria	300				
Czechoslovakia	1,173,935	1,229,954	1,421,174	1,590,527	1,779,176
Finland	(³)	226			(³)
France	29,044,149	35,597,704	39,317,700	45,670,920	49,327,839
Germany ⁷	4,284,789	5,742,542	4,594,937	6,004,836	(³)
Greece	102,221	88,216	126,624	123,865	166,868
Hungary	101,750	68,517	132,309	194,400	199,547
Italy	218,726	495,905	504,556	503,290	625,488
Luxemburg	5,333,580	6,672,092	7,756,240	7,266,249	7,026,832
Netherlands				1,000	(³)
Norway	522,124	425,424	212,661	479,334	(³)
Poland	293,021	214,062	316,847	540,801	698,935
Portugal	8,573	2,000	1,640	7,600	(³)
Rumania	102,537	107,384	102,799	97,138	83,869
Russia ⁸	932,969	2,201,706	3,415,278	4,791,530	(³)
Spain	4,612,817	4,442,872	3,181,589	4,960,394	5,771,207
Sweden	6,499,730	8,168,546	8,465,914	9,660,977	4,672,878
Switzerland ⁹	81,375	59,513	49,995	81,661	(³)
United Kingdom—					
Great Britain ¹⁰	11,227,951	10,305,671	4,160,101	11,386,467	11,443,083
Northern Ireland	6,941	3,498	(³)	5,303	819
Yugoslavia	330,119	139,137	366,624	336,099	439,481
Asia:					
China	1,100,000	1,519,000	⁹ 525,426	⁹ 501,889	(³)
Chosen	309,443	351,444	351,575	483,996	504,375
India, British	1,468,510	1,569,368	1,685,927	1,876,375	(³)
Japan	57,922	75,765	130,420	159,005	(³)
Russia ⁸	11,626	22,752	15,154	21,476	(³)
Unfederated Malay States—Johore	238,892	276,358	254,100	416,548	654,981
Africa:					
Algeria	1,662,506	1,780,842	1,629,425	2,004,189	1,985,626
Belgian Congo	105,195	87,258	113,511	78,000	51,000
Madagascar	(³)	6	1	(¹¹)	(³)
Morocco—					
French				1,050	(³)
Spanish	(³)	800,000	⁹ 467,350	⁹ 997,111	⁹ 1,060,709
Rhodesia—					
Northern				3,474	4,538
Southern		1,063	1,923	477	3,112
Southwest African Protectorate	5,835	14,161	17,869	21,753	29,929
Tunisia	797,680	724,000	582,000	915,000	909,000
Union of South Africa ¹			47,200	77,523	20,898
Oceania:					
Australia—					
New South Wales ²	142,852	157,735	159,788	182,999	85,558
Queensland		351	4,483	515	
South Australia	589,622	596,068	593,114	734,020	628,240
New Zealand	2,550	2,620	8,122	(³)	(³)

¹ Shipments.

² Exclusive of iron oxide used for paint.

³ Data not available.

⁴ Shipments from Wabana mines.

⁵ Approximate production.

⁶ Production of Tofo mine.

⁷ Exclusive of manganiferous iron ore carrying 12 to 30 per cent of manganese.

⁸ Year ended Sept. 30.

⁹ Exports.

¹⁰ Exclusive of bog ore, which is used mainly for the purification of gas.

¹¹ 175 kilograms.

BENEFICIATED IRON ORE

In 1928 the processes reported in use in the United States to improve the quality of the ore at the mines were crushing and screening, drying, hand picking, washing, jigging, electromagnetic separation, sintering, nodulizing, and desulphurization by sintering. Some operators combined two or more of these processes. Beneficiation of iron ore was reported at 62 mines in 12 States in 1928 and at 58 mines in 11 States in 1927. Some iron ore is also recovered in the form of dust from blast furnaces, but no statistics on it have been gathered. Ore so recovered, however, has been originally included in the statistics of shipments from the mines.

Beneficiated ore shipped from mines in the United States in 1928 increased 6 per cent in quantity and 4 per cent in total value as compared with 1927. Such figures as are available for 1928 to show the relation between crude ore treated and beneficiated ore recovered indicate that in washing brown ore the ratios, by weight, of crude ore washed to resultant concentrates range from 4:1 to 3:1, in concentrating hematite from 2.096:1 to 1.056:1, in concentrating magnetite from 2.5:1 to 1.024:1, and in concentrating carbonate 1.333:1.

The quantity of crude ore beneficiated in the Lake Superior district in 1928 amounted to 8,969,662 gross tons, and the beneficiated ore recovered was 5,435,929 tons—a loss of 3,533,733 tons and a ratio of 1.65:1. In 1927 the crude Lake ore treated amounted to 8,045,457 tons, and the beneficiated ore recovered therefrom was 4,927,995 tons—a loss of 3,117,462 tons and a ratio of 1.633:1.

Beneficiated iron ore shipped from mines in the United States, 1927 and 1928

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint]

State	Variety	1927		1928	
		Gross tons	Value	Gross tons	Value
Alabama.....	Brown ore.....	607, 681	\$1, 567, 178	649, 645	\$1, 546, 671
Georgia.....	do.....	49, 010	143, 161	73, 052	209, 877
Minnesota.....	Hematite.....	4, 952, 537	12, 214, 099	5, 485, 096	14, 703, 265
Missouri.....	do.....	47, 605	(1)	69, 899	(1)
New Jersey.....	Magnetite.....	201, 382	852, 366	348, 126	1, 345, 338
New Mexico.....	do.....	214, 747	(1)	184, 623	(1)
New York.....	do.....	936, 850	4, 568, 224	767, 743	2, 906, 055
Pennsylvania.....	do.....	843, 363	3, 433, 941	788, 044	3, 162, 303
Tennessee.....	Hematite, brown ore.....	106, 637	251, 904	127, 323	283, 925
Virginia.....	do.....	66, 874	172, 643	27, 902	82, 914
Wisconsin.....	Hematite.....	87, 987	(1)	19, 208	(1)
Wyoming.....	do.....			80, 670	(1)
Undistributed.....			970, 945		833, 238
		8, 114, 673	24, 174, 461	8, 621, 331	25, 073, 586

¹ Included under "Undistributed."

The next table gives the shipments of beneficiated iron ore beginning with 1914, the first year for which statistics were gathered, and the percentage of beneficiated ore to the total ore shipped. Except for a few years the increase in the proportion of beneficiated ore has been slow but steady. During the 5-year period 1914 to 1918 the shipments of beneficiated ore averaged 10.6 per cent of the total ore and increased to 13.5 per cent during the next 5-year period (1919 to 1923) but decreased to 13.2 per cent during the 5-year period 1924

to 1928. Minnesota has contributed more than 64 per cent of the total shipments of beneficiated ore during the period 1914 to 1928. During the 5-year period 1914 to 1918 an average of 10.2 per cent of the total shipments from Minnesota was beneficiated ore; during each of the 5-year periods 1919 to 1923 and 1924 to 1928 the proportion was 14.9 per cent.

Iron ore shipped from mines in the United States, 1914-1928, in gross tons, and percentage of beneficiated ore to the total shipped

[Exclusive of ore containing 5 per cent or more of manganese and of ore sold for paint]

Year	Bene- ficiated	Total	Percentage of bene- ficiated to total	Year	Bene- ficiated	Total	Percentage of bene- ficiated to total
1914.....	4, 130, 298	39, 714, 280	10. 4	1922.....	6, 623, 144	50, 612, 620	13. 1
1915.....	5, 581, 029	55, 493, 100	10. 1	1923.....	10, 686, 992	69, 811, 472	15. 3
1916.....	8, 105, 011	77, 870, 553	10. 4	1924.....	7, 092, 539	52, 083, 375	13. 6
1917.....	8, 166, 564	75, 573, 207	10. 8	1925.....	8, 735, 672	63, 924, 763	13. 7
1918.....	7, 881, 570	72, 021, 202	10. 9	1926.....	8, 371, 829	69, 292, 832	12. 1
1919.....	7, 355, 934	56, 372, 784	13. 0	1927.....	8, 114, 673	61, 232, 473	13. 3
1920.....	8, 514, 838	69, 281, 341	12. 3	1928.....	8, 621, 331	63, 432, 826	13. 6
1921.....	3, 727, 621	26, 652, 523	14. 0				

IRON AND STEEL

The records of the production and sales of iron and steel shown in the following pages are derived in part from data supplied by producers who report direct to the Bureau of Mines and in part from several other authoritative sources, such as the American Iron and Steel Institute, Metal Statistics, the Iron Age, and the Iron Trade Review. The statistics on imports and exports are from the Bureau of Foreign and Domestic Commerce.

PIG IRON

SHIPMENTS, VALUE, AND PRODUCTION, BY STATES

The shipments of pig iron, exclusive of ferro-alloys, reported by the manufacturers to the Bureau of Mines, amounted to 38,303,699 gross tons, valued at \$661,351,270, in 1928, an increase of 10 per cent in quantity and 2 per cent in total value as compared with 1927. The values given represent the approximate amounts received for the iron f. o. b. furnaces and do not include freight costs, selling commissions, and other items that are figured in some of the market prices of pig iron as published in trade journals.

The pig iron shipped includes metal produced from foreign as well as from domestic ore. Although the pig iron made from ore imported from Africa, Asia, Australia, Brazil, Chile, Cuba, Newfoundland, Spain, and Sweden constitutes a very small percentage of the total production, it amounted in 1928 to 1,579,242 gross tons, valued at \$29,508,576, as compared with 1,414,594 tons, valued at \$27,161,285, from foreign ore in 1927. In the manufacture during 1928 of 1,557,218 gross tons of pig iron 2,625,620 gross tons of foreign iron ore was reported to have been used, indicating an average pig-iron yield of 59.31 per cent from imported ore. Domestic ore and 6,026,785 gross tons of cinder, scale, and scrap, amounting in

all to 69,822,340 tons, were reported used in making 35,853,679 tons of pig iron, indicating an average pig-iron yield of 51.35 per cent from domestic materials. The total production of pig iron, exclusive of ferro-alloys, reported to the Bureau of Mines, was 37,410,897 gross tons, compared with 35,875,129 tons in 1927, an increase of 4 per cent.

Pig iron shipped from blast furnaces in the United States, 1927 and 1928, by States

State	1927		1928	
	Gross tons	Value	Gross tons	Value
Alabama.....	2, 705, 240	\$50, 193, 057	2, 525, 812	\$42, 194, 935
Colorado.....	(1)	(1)	(1)	(1)
Illinois.....	3, 466, 203	66, 442, 068	4, 094, 514	73, 524, 773
Indiana.....	3, 447, 764	62, 097, 518	3, 842, 762	63, 622, 330
Kentucky.....	184, 851	(1)	225, 545	(1)
Maryland.....	845, 564	(1)	971, 832	(1)
Massachusetts.....	129, 039	(1)	(1)	(1)
Michigan.....	626, 532	12, 527, 993	797, 776	15, 157, 535
Minnesota.....	287, 813	(1)	341, 203	(1)
New York.....	2, 401, 432	40, 803, 579	2, 369, 814	39, 928, 960
Ohio.....	8, 184, 066	150, 125, 790	9, 266, 936	156, 833, 186
Pennsylvania.....	11, 145, 334	212, 179, 275	12, 289, 455	216, 425, 084
Tennessee.....	87, 971	1, 911, 380	102, 718	1, 920, 901
Utah.....	(1)	(1)	164, 071	(1)
Virginia.....	84, 920	1, 782, 538	63, 175	1, 245, 809
West Virginia.....	504, 816	(1)	645, 038	(1)
Wisconsin.....	(1)	(1)	(1)	(1)
Undistributed.....	¹ 765, 099	² 48, 162, 941	² 603, 048	² 50, 447, 757
	34, 866, 644	646, 226, 139	38, 303, 699	661, 351, 270

¹ Included under "Undistributed."

² Includes figures for States entered as "(1)" above.

Pig iron shipped from blast furnaces in the United States, 1927 and 1928, by grades

Grade	1927			1928		
	Gross tons	Value		Gross tons	Value	
		Total	Average		Total	Average
Charcoal.....	140, 728	\$3, 482, 097	\$24. 74	157, 129	\$3, 600, 847	\$22. 92
Foundry.....	4, 889, 889	91, 015, 404	18. 61	4, 635, 241	80, 663, 751	17. 40
Basic.....	19, 295, 759	346, 842, 546	17. 98	22, 161, 988	370, 335, 434	16. 71
Bessemer.....	8, 292, 184	161, 106, 090	19. 43	8, 819, 220	160, 057, 038	18. 15
Low-phosphorus.....	303, 027	7, 030, 622	23. 20	297, 473	6, 692, 910	22. 50
Malleable.....	1, 606, 153	29, 895, 697	18. 61	2, 007, 868	35, 254, 883	17. 56
Forge.....	147, 016	2, 840, 605	19. 32	89, 520	1, 633, 229	18. 24
All other (not ferro-alloys).....	191, 888	4, 013, 078	20. 91	135, 260	3, 113, 178	23. 02
	34, 866, 644	646, 226, 139	18. 53	38, 303, 699	661, 351, 270	17. 27

Pig iron shipped from blast furnaces in the United States, 1910-1928

Year	Gross tons	Value	Year	Gross tons	Value
1910.....	26, 674, 123	\$412, 162, 486	1920.....	35, 710, 227	\$1, 140, 904, 096
1911.....	23, 257, 288	327, 334, 624	1921.....	16, 038, 619	389, 437, 792
1912.....	30, 180, 969	420, 563, 388	1922.....	27, 670, 738	608, 144, 858
1913.....	30, 388, 935	458, 342, 345	1923.....	38, 361, 379	946, 799, 378
1914.....	22, 263, 263	298, 777, 429	1924.....	31, 064, 129	665, 078, 972
1915.....	30, 384, 486	401, 409, 604	1925.....	36, 814, 702	739, 316, 333
1916.....	39, 126, 324	663, 478, 118	1926.....	38, 181, 053	749, 633, 468
1917.....	38, 612, 546	1, 053, 785, 975	1927.....	34, 866, 644	646, 226, 139
1918.....	38, 230, 440	1, 180, 759, 565	1928.....	38, 303, 699	661, 351, 270
1919.....	30, 130, 231	775, 915, 043			

The American Iron and Steel Institute reports that in 1928 the output of all kinds of pig iron and ferro-alloys increased 1,590,069 gross tons, or 4 per cent, as compared with 1927.

*Pig iron (including ferro-alloys) manufactured in the United States, 1927 and 1928, in gross tons*¹

State	1927	1928	State	1927	1928
Pennsylvania.....	11,829,599	12,422,602	West Virginia.....	699,514	864,922
Ohio.....	8,502,459	9,098,739	Kentucky.....		
Illinois.....	3,588,595	3,942,412	Iowa.....	641,057	634,270
Alabama.....	2,782,993	2,546,009	Colorado.....		
Indiana.....	4,201,802	4,683,065	Utah.....		
Michigan.....			Maryland.....	855,566	1,050,876
New York.....	2,775,351	2,562,715	Virginia.....	99,197	
Massachusetts.....			Tennessee.....	133,785	
Wisconsin.....	455,727	339,267		36,565,645	38,155,714
Minnesota.....					

¹ American Iron and Steel Institute.

AVERAGE VALUES

Values at blast furnaces.—The average value of all kinds of pig iron given in the accompanying table is based on the reports of the manufacturers to the Bureau of Mines. The figures represent the approximate values f. o. b. at the blast furnaces and do not include the values of ferro-alloys. The general average value for all grades of pig iron at the furnaces, exclusive of ferro-alloys, decreased 7 per cent in 1928 and was the lowest for any year since 1916.

Average value per gross ton of pig iron at blast furnaces in the United States, 1923-1928

State	1923	1924	1925	1926	1927	1928
Alabama.....	\$19.72	\$20.92	\$19.85	\$20.21	\$18.55	\$16.71
Illinois.....	25.36	22.00	20.81	20.26	19.17	17.96
Indiana.....	23.26	20.42	19.34	18.88	18.01	16.56
Michigan.....	26.25	23.41	22.19	20.65	20.00	19.00
New York.....	23.71	19.93	18.80	18.82	16.99	16.85
Ohio.....	24.76	21.48	19.58	19.23	18.34	16.93
Pennsylvania.....	25.02	21.62	20.59	20.03	19.04	17.61
Tennessee.....	26.95	21.97	21.16	22.51	21.73	18.70
Virginia.....	26.76	24.01	22.86	22.11	20.99	19.72
West Virginia.....	24.68	21.77	18.87	(1)	(1)	(1)
Wisconsin.....	25.90	22.88	21.34	21.37	(1)	(1)
Other States ²	24.73	21.57	19.83	18.59	17.73	17.10
Average for United States.....	24.68	21.41	20.08	19.63	18.53	17.27

¹ Included under "Other States."

² 1923: Colorado, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, and New Jersey; 1924: Colorado, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and Utah; 1925: Colorado, Kentucky, Maryland, Minnesota, Missouri, New Jersey, and Utah; 1926: Colorado, Kentucky, Maryland, Massachusetts, Minnesota, New Jersey, Utah, and West Virginia; 1927-1928: Colorado, Kentucky, Maryland, Massachusetts, Minnesota, Utah, West Virginia, and Wisconsin.

Average value per gross ton of pig iron at blast furnaces in the United States, 1889-1928

1889-----	\$15. 78	1903-----	\$19. 12	1917-----	\$27. 29
1890-----	16. 43	1904-----	14. 13	1918-----	30. 89
1891-----	15. 50	1905-----	16. 63	1919-----	25. 75
1892-----	14. 32	1906-----	19. 98	1920-----	31. 95
1893-----	11. 90	1907-----	20. 56	1921-----	24. 28
1894-----	9. 76	1908-----	15. 96	1922-----	21. 98
1895-----	11. 14	1909-----	16. 25	1923-----	24. 68
1896-----	10. 47	1910-----	15. 45	1924-----	21. 41
1897-----	9. 85	1911-----	14. 07	1925-----	20. 08
1898-----	9. 90	1912-----	13. 93	1926-----	19. 63
1899-----	18. 00	1913-----	15. 08	1927-----	18. 53
1900-----	18. 85	1914-----	13. 42	1928-----	17. 27
1901-----	15. 25	1915-----	13. 21		
1902-----	20. 92	1916-----	16. 96		

Commercial quotations.—The average monthly prices, according to published market quotations, of the chief grades of pig iron at the blast furnaces or at the nearest market during 1927 and 1928 are summarized in the following table for comparison with preceding tables giving the figures reported by blast-furnace operators. The average commercial quotations for each of the four grades of iron show a decrease and are lower than the average values reported by manufacturers, but the reader should remember that the manufacturers' values represent weighted averages of what was actually received for the metal, and a discrepancy between the two sets of figures is to be expected.

Average monthly prices per ton of chief grades of pig iron, 1927 and 1928¹

Month	Foundry pig iron at Valley furnaces		Foundry pig iron at Birmingham furnaces		Bessemer pig iron at Valley furnaces		Basic pig iron at Valley furnaces	
	1927	1928	1927	1928	1927	1928	1927	1928
January-----	\$18. 50	\$17. 25	\$18. 56	\$16. 00	\$19. 50	\$17. 50	\$18. 16	\$17. 00
February-----	18. 50	17. 25	18. 00	16. 00	19. 02	17. 50	18. 00	17. 00
March-----	18. 50	17. 25	18. 00	16. 00	19. 37	17. 50	18. 28	17. 00
April-----	18. 50	17. 25	18. 00	16. 00	19. 50	17. 50	19. 00	17. 00
May-----	18. 50	17. 24	18. 00	15. 69	19. 24	17. 37	18. 24	16. 38
June-----	18. 35	16. 79	18. 00	15. 88	18. 96	17. 00	17. 96	15. 56
July-----	18. 00	16. 69	17. 64	15. 50	18. 50	17. 00	17. 50	15. 75
August-----	17. 65	16. 50	17. 12	15. 64	18. 50	17. 00	17. 32	15. 75
September-----	17. 50	16. 50	17. 25	16. 25	18. 00	17. 00	17. 11	15. 75
October-----	17. 50	16. 74	17. 20	16. 25	18. 00	17. 24	17. 00	16. 66
November-----	17. 47	17. 32	16. 00	16. 37	18. 00	17. 82	17. 00	17. 32
December-----	17. 25	17. 50	16. 00	16. 37	17. 69	18. 00	17. 00	17. 50
Average-----	18. 02	17. 02	17. 48	16. 01	18. 69	17. 37	17. 71	16. 56

¹ Metal Statistics, 1929.

PRODUCTION BY GRADES AND BY FUEL USED, TOTAL PRODUCTION, AND BLAST FURNACES

The statistics of production of pig iron by grades and by fuel used for 1924 to 1928, the total output of pig iron, and the number of furnaces in blast in 1927 and 1928 have been published by the American Iron and Steel Institute, as shown in the tables that follow. These figures include ferro-alloys. Metals produced by the use of electricity and by the use of coke and electricity together are included in coke pig iron.

Pig iron (including ferro-alloys) manufactured in the United States, 1924-1928, by grades, in gross tons

Grade	1924	1925	1926	1927	1928
Bessemer and low-phosphorus-----	8, 172, 297	9, 419, 461	10, 042, 324	9, 105, 915	9, 013, 847
Basic-----	15, 999, 012	19, 667, 380	21, 168, 407	19, 357, 064	22, 124, 410
Forge-----	255, 961	240, 652	216, 277	144, 532	88, 362
Foundry and ferrosilicon-----	5, 623, 124	5, 410, 217	5, 752, 573	5, 782, 696	4, 513, 385
Malleable-----	973, 158	1, 553, 636	1, 681, 897	1, 699, 583	1, 922, 970
Spiegeleisen-----	107, 066	65, 755	76, 215	100, 720	} 419, 213
Ferromanganese-----	194, 243	260, 029	318, 891	293, 626	
White, mottled, direct castings, and other ferro-alloys-----	80, 929	83, 436	116, 145	81, 509	73, 527
	31, 405, 790	36, 700, 566	39, 372, 729	36, 565, 645	38, 155, 714

Pig iron (including ferro-alloys) manufactured in the United States, 1924-1928, by fuel used, in gross tons

Fuel used	1924	1925	1926	1927	1928
Bituminous, chiefly coke-----	31, 193, 080	36, 504, 402	39, 208, 849	36, 398, 791	38, 012, 754
Charcoal-----	212, 710	196, 164	163, 880	166, 854	142, 960
	31, 405, 790	36, 700, 566	39, 372, 729	36, 565, 645	38, 155, 714

The next table shows the production in the United States of pig iron, including ferro-alloys, so far as it has been recorded. Statistics by years prior to 1916 will be found in Mineral Resources for 1918 and earlier years.

Pig iron (including ferro-alloys) manufactured in the United States, 1810-1928, in gross tons

1810-1860-----	10, 542, 548	1920-----	36, 925, 987
1861-1870-----	11, 366, 963	1921-----	16, 688, 126
1871-1880-----	24, 055, 278	1922-----	27, 219, 904
1881-1890-----	56, 902, 041	1923-----	40, 361, 146
1891-1900-----	98, 124, 754	1924-----	31, 405, 790
1901-1910-----	211, 321, 934	1925-----	36, 700, 566
1911-1915-----	137, 591, 093	1926-----	39, 372, 729
1916-----	39, 434, 797	1927-----	36, 565, 645
1917-----	38, 621, 216	1928-----	38, 155, 714
1918-----	39, 054, 644		
1919-----	31, 015, 364		1, 001, 426, 239

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for 1927 and 1928, exclusive of electric reduction furnaces, were as follows:

Blast furnaces (including ferro-alloy blast furnaces) in the United States, 1927 and 1928

State	In blast June 30, 1927	Dec. 31, 1927			In blast June 30, 1928	Dec. 31, 1928		
		In	Out	Total		In	Out	Total
Alabama.....	19	18	17	35	17	19	13	32
Colorado.....	3	3	2	5	3	3	2	5
Illinois.....	17	16	10	26	15	17	8	25
Indiana.....	15	11	7	18	14	14	4	18
Kentucky.....	2	1	4	5	2	2	3	5
Maryland.....	5	5	1	6	5	5	1	6
Massachusetts.....	1	1	1	1	1	1	1	1
Michigan.....	10	10	1	11	8	8	2	10
Minnesota.....	2	2	1	3	2	2	1	3
Mississippi.....	-----	-----	1	1	-----	-----	1	1
Missouri.....	-----	-----	2	2	-----	-----	2	2
New Jersey.....	-----	-----	2	2	-----	-----	2	2
New York.....	15	14	11	25	13	13	10	23
Ohio.....	44	37	32	69	46	45	18	63
Pennsylvania.....	62	54	61	115	60	68	39	107
Tennessee.....	4	2	11	13	3	1	10	11
Texas.....	-----	-----	1	1	-----	-----	1	1
Utah.....	1	-----	1	1	1	1	-----	1
Virginia.....	1	1	14	15	2	1	10	11
West Virginia.....	3	2	3	5	3	3	1	4
Wisconsin.....	1	1	4	5	-----	-----	3	3
	205	178	186	364	195	203	131	334

FOREIGN TRADE IN PIG IRON

Imports of pig iron into the United States during 1928 increased 6 per cent in quantity but decreased 1 per cent in total value as compared with 1927. India was again the chief source of imported pig iron in 1928, supplying 40 per cent of the total; the United Kingdom and the Netherlands were other important sources, supplying 36 and 19 per cent, respectively, of the total.

Pig iron imported into the United States, 1924-1928, by countries, in gross tons

Country	1924	1925	1926	1927	1928
North America:					
Canada.....	15,933	6,455	4,767	725	1,015
Dominican Republic.....	-----	3	-----	-----	-----
Honduras.....	200	-----	-----	-----	-----
Mexico.....	-----	-----	70	97	423
Europe:					
Belgium.....	3,019	11,068	7,488	699	272
France.....	23,208	9,814	28,449	3,000	30
Germany.....	11,228	75,052	157,094	9,211	695
Ireland.....	50	-----	-----	-----	-----
Netherlands.....	23,857	54,904	69,054	29,380	26,989
Norway.....	-----	-----	2	-----	1,186
Sweden.....	700	2,169	3,455	1,700	2,720
United Kingdom—					
England.....	52,593	96,869	92,083	21,129	50,944
Scotland.....	4,546				
Asia:					
China.....	2,375	200	-----	-----	-----
India, British.....	71,370	184,325	83,311	66,627	56,420
Japan.....	-----	(¹)	-----	-----	-----
Kwantung.....	30	566	-----	-----	-----
	209,109	441,425	445,773	132,568	140,694
Value.....	\$3,741,213	\$7,951,283	\$7,708,982	\$2,254,355	\$2,232,094

¹ Less than 1 ton.

Pig iron¹ imported into the United States, 1919-1928

Year	Gross tons	Value	Year	Gross tons	Value
1919 ¹	101,665	\$6,565,106	1924.....	209,109	\$3,741,213
1920 ¹	185,944	12,801,834	1925.....	441,425	7,951,283
1921 ¹	44,036	2,014,926	1926.....	445,773	7,708,982
1922.....	383,445	8,670,860	1927.....	132,568	2,254,355
1923.....	367,778	9,005,077	1928.....	140,694	2,232,094

¹ Figures for 1919 to 1921, inclusive, include ferro-alloys. Separate data not available prior to 1922.

Exports of pig iron from the United States increased 66 per cent in quantity and 33 per cent in total value in 1928, as compared with 1927. Japan (including Chosen), which took only 9 per cent of the total exports in 1927, was the best customer in 1928, taking 47 per cent of the total; Canada was next best, taking 46 per cent of the total. The average value of the pig iron exported was \$16.14 a ton in 1928, as compared with \$20.17 a ton in 1927.

Pig iron exported from the United States, 1927 and 1928, by countries, in gross tons

Country	1927	1928	Country	1927	1928
North America:			Europe—Continued.		
Canada.....	35,128	39,342	Germany.....	275	513
Cuba.....	763	595	Italy.....	96	223
Mexico.....	131	54	United Kingdom.....	6,910	217
Panama.....	450	909	Other countries.....	90	66
Other countries.....	73	285	Asia:		
South America:			China.....	1	304
Chile.....	908	440	Japan, including Cho-		
Colombia.....	271	75	sen.....	4,398	39,762
Peru.....	500	106	Philippine Islands.....	455	463
Other countries.....	37	245	Oceania: New Zealand.....		6
Europe:				50,992	84,682
Belgium.....	506	1,000	Value.....	\$1,028,425	\$1,366,794
France.....		77			

Pig iron¹ exported from the United States, 1919-1928

Year	Gross tons	Value	Year	Gross tons	Value
1919 ¹	321,261	\$12,313,183	1924.....	41,483	\$957,921
1920 ¹	216,828	10,074,377	1925.....	32,674	724,565
1921 ¹	28,307	933,093	1926.....	25,208	523,883
1922.....	30,920	756,842	1927.....	50,992	1,028,425
1923.....	32,318	862,443	1928.....	84,682	1,366,794

¹ Figures for 1919 to 1921, inclusive, include ferro-alloys. Separate data not available prior to 1922.

WORLD PRODUCTION OF PIG IRON, BY COUNTRIES

The accompanying table shows the predominance of the United States in the manufacture of pig iron and, with the table giving exports from the United States, indicates that the consumption in the principal European countries is still comparatively small.

Pig iron (including ferro-alloys) produced, 1924-1928, by countries, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924	1925	1926	1927	1928
Australia.....	422,728	446,472	445,739	525,525	417,468
Austria.....	266,463	379,921	331,635	432,749	458,451
Belgium.....	2,843,920	2,542,507	3,368,347	3,709,090	3,905,320
Brazil ¹	70,000	70,000	70,000	70,000	70,000
Canada.....	629,386	605,674	827,809	778,220	1,100,146
China.....	480,000	369,617	400,000	300,000	² 300,000
Chosen.....	99,795	101,933	118,102	129,022	148,652
Czechoslovakia.....	983,042	1,166,422	1,087,984	1,260,363	1,569,264
Finland.....	10,653	11,352	8,871	11,860	8,470
France.....	7,692,565	8,505,244	9,430,025	9,297,000	10,097,000
Germany (exclusive of the Saar).....	7,832,554	10,088,751	9,636,054	13,102,528	11,804,330
Saar.....	1,389,117	1,453,056	1,638,051	1,770,718	1,936,184
Great Britain.....	7,436,368	6,362,200	2,497,654	7,409,951	6,717,411
Hungary.....	115,502	93,130	189,208	300,237	285,461
India, British.....	923,125	906,838	936,932	1,163,523	1,026,000
Italy.....	341,317	536,245	558,509	529,489	548,828
Japan ³	598,237	695,916	1,198,939	1,284,487	1,397,000
Luxemburg.....	2,157,170	2,363,253	2,559,151	2,723,356	2,770,066
Mexico.....	19,485	49,373	61,796	41,860	² 42,000
Netherlands.....	106,000	109,100	² 150,000	204,000	² 200,000
New Zealand.....	640	1,310	4,061	3,437	6,464
Norway.....	64,955	87,931	97,311	119,836	² 100,000
Philippine Islands.....	273	398	306	200	197
Poland.....	334,341	314,564	327,471	618,203	683,951
Rumania.....	46,081	64,273	62,979	63,498	70,123
Russia ⁴	669,642	1,308,733	2,217,933	2,953,514	3,373,500
Spain.....	510,279	530,029	488,696	593,070	562,821
Sweden.....	532,604	458,535	494,663	454,518	394,900
Union of South Africa.....			20,382	30,610	9,057
United States.....	31,909,853	37,289,610	40,004,661	37,152,524	38,768,113
Yugoslavia.....	15,019	3,494	18,768	22,651	29,303
	68,501,000	76,916,000	79,252,000	87,056,000	88,800,000

¹ Official estimate of annual production.

² Approximate production.

³ Includes pig iron produced at Government and other steelworks for conversion into steel.

⁴ Year ended Sept. 30.

FERRO-ALLOYS

PRODUCTION, SHIPMENTS, VALUE, AND PRICES

In these reports the statistics on the output of ferro-alloys in the United States are separated from those of pig iron in order that the values given may be more nearly accurate. Although the quantity of ferro-alloys is relatively small, the values per ton are so high that failure to separate the figures would unduly increase the apparent average value of the pig iron.

The shipments of ferro-alloys of all classes in 1928 increased 23 per cent in quantity and 21 per cent in total value as compared with 1927. The production of ferro-alloys was 757,131 gross tons in 1928, compared with 709,649 tons in 1927, an increase of 7 per cent. Ferro-alloys were made in 1928 at 14 blast furnaces, 13 electric furnaces, and 2 alumino-thermic plants; in addition, 2 plants made ferrosilicon and 1 plant made ferrophosphorus as a by-product.

Ferro-alloys shipped from furnaces in the United States, 1927 and 1928, by varieties

Variety of alloy	1927		1928	
	Gross tons	Value	Gross tons	Value
Ferromanganese.....	291,056	\$27,243,489	310,122	\$29,199,990
Silicomanganese and silicospiegeleisen.....	3,173	301,321	(1)	(1)
Spiegeleisen.....	80,892	1,986,188	116,911	2,802,108
Ferrosilicon (7 per cent or more silicon).....	232,576	11,903,782	310,770	15,199,746
Ferrotungsten.....	1,289	2,185,788	1,975	3,195,690
Ferrovandium.....	1,467	3,939,067	1,895	5,085,759
Other varieties ²	36,296	7,603,939	53,022	11,094,746
	646,749	55,163,574	794,695	66,578,039

¹ Included under "Other varieties."

² 1927: Ferrochromium, ferromolybdenum and calcium-molybdenum compounds, ferrophosphorus, ferrotitanium, ferrozirconium, and zirconium-ferrosilicon; 1928: Ferrochromium, ferromolybdenum and calcium-molybdenum compounds, ferrophosphorus, ferrotitanium, ferrozirconium, silicomanganese and silicospiegeleisen, and zirconium-ferrosilicon.

Ferro-alloys shipped from furnaces in the United States, 1919-1928, in gross tons

Year	Ferro-manganese	Spiegel-eisen	Other varieties	Total	
				Quantity	Value
1919.....	198,255	90,855	130,528	419,638	\$53,730,964
1920.....	276,594	103,672	232,542	612,808	77,519,367
1921.....	111,374	69,230	68,023	248,627	21,697,785
1922.....	161,612	70,253	191,415	423,280	28,259,004
1923.....	226,365	134,086	219,366	579,817	49,877,238
1924.....	232,821	76,179	188,244	497,244	43,249,941
1925.....	254,005	95,890	266,327	616,222	53,048,100
1926.....	330,070	82,982	276,206	689,258	61,368,407
1927.....	291,056	80,892	274,801	646,749	55,163,574
1928.....	310,122	116,911	367,662	794,695	66,578,039

The following records of average contract prices of ferromanganese and of spiegeleisen, by months, for the last four years show a wide range. The ferromanganese prices are quoted for material "delivered at Pittsburgh"; those for spiegeleisen are prices at producers' furnaces.

Quoted prices per ton of ferromanganese and spiegeleisen, 1925-1928 ¹

Month	Ferromanganese (delivered at Pittsburgh)				Spiegeleisen (at producers' furnaces)			
	1925	1926	1927	1928	1925	1926	1927	1928
January.....	\$116.79	\$119.79	\$104.79	\$104.79	\$32.00	\$34.00	\$37.00	\$32.00
February.....	119.79	119.79	104.79	104.79	33.00	34.00	37.00	32.00
March.....	119.79	102.29	104.79	104.79	33.00	34.00	37.00	32.00
April.....	119.79	92.79	104.79	104.79	33.00	34.00	37.00	32.00
May.....	119.79	92.79	98.55	108.19	33.00	34.00	35.00	32.00
June.....	119.79	92.79	94.79	109.79	32.00	34.00	34.80	32.00
July.....	119.79	92.79	94.79	109.79	31.50	34.00	34.00	33.00
August.....	119.79	92.79	94.79	109.79	32.25	34.00	33.35	33.00
September.....	119.79	92.79	94.79	109.79	33.00	34.00	33.00	33.00
October.....	119.79	99.79	94.79	109.79	33.00	34.00	30.15	33.00
November.....	119.79	104.79	94.79	109.79	34.00	38.75	30.00	33.00
December.....	119.79	104.79	103.42	109.79	34.00	37.00	31.00	34.00

¹ Iron Trade Review.

Ferromanganese.—The shipments of ferromanganese in 1928 amounted to 310,122 gross tons, an increase of 7 per cent over 1927. The average value per ton f. o. b. furnaces reported for ferromanganese was \$94.16 in 1928, compared with \$93.60 in 1927. Ferromanganese was made at seven furnaces by three producers in both 1928 and 1927.

The production of ferromanganese in 1928 was 319,770 gross tons, containing about 251,400 tons of manganese (metal), an average of 78.62 per cent of manganese. In the production of ferromanganese in 1928 there were used 566,859 gross tons of foreign manganese ore, 37,827 tons of domestic manganese ore, 23,159 tons of iron ore and manganiferous iron ore, and 8,395 tons of cinder, scale, and scrap. The quantity of manganese ore used per ton of ferromanganese made in 1928 was 1.891 tons; in 1927 it was 2 tons; and in 1926 it was 2.063 tons. Of the foreign manganese ore used in 1928 Brazil supplied 218,181 gross tons; Russia, 208,009 tons; India, 96,232 tons; Africa, 25,039 tons; Cuba, 14,280 tons; and Chile, 5,118 tons. The quantity of domestic manganese ore used in the manufacture of ferromanganese in 1928 represented 6.3 per cent of the total manganese ore used, as compared with 4.3 per cent in 1927.

Manganese ore and other metallic materials consumed and ferromanganese produced in the United States, 1921-1928

Year	Materials consumed (gross tons)				Ferromanganese produced			Manganese ore used per ton of ferromanganese made (gross tons)
	Manganese ore		Iron and manganiferous iron ores	Cinder, scale, and scrap	Gross tons	Manganese contained		
	Foreign	Domestic				Per cent	Gross tons	
1921-----	208,376	17,839	143	2,092	104,129	76.17	79,319	2.172
1922-----	335,165	1,804	-----	5,252	150,010	78.55	117,836	2.246
1923-----	538,280	26,790	498	6,945	251,938	78.13	196,844	2.243
1924-----	443,260	20,133	909	4,434	211,965	78.21	165,776	2.186
1925-----	519,139	34,942	4,949	11,072	259,780	78.93	205,046	2.133
1926-----	610,898	36,309	8,064	5,122	318,052	79.25	252,066	2.063
1927-----	564,725	25,298	12,735	8,570	294,991	78.95	232,900	2.000
1928-----	566,859	37,827	23,159	8,395	319,770	78.62	251,400	1.891

Manganese ore used in the manufacture of ferromanganese in the United States, 1927 and 1928, by sources of ore, in gross tons

Source of ore	1927	1928
Africa-----	41,470	25,039
Brazil-----	245,485	218,181
Chile-----	3,746	5,118
Cuba-----	9,408	14,280
India-----	78,548	96,232
Porto Rico-----	1,666	-----
Russia-----	184,402	208,009
United States-----	564,725	566,859
	25,298	37,827
	590,023	604,686

Spiegeleisen.—The shipments of spiegeleisen in 1928 amounted to 116,911 gross tons, or 45 per cent more than in 1927. The average value per ton at the furnaces in 1928 was \$23.97; in 1927 it was \$24.55. Spiegeleisen was made at 4 furnaces by 3 producers in 1928 and at 5 furnaces by 3 producers in 1927.

The production of spiegeleisen in 1928 was 99,517 gross tons, containing about 19,200 tons of manganese (metal), an average of about 19.29 per cent.

Ferrosilicon.—The production of ferrosilicon in 1928 amounted to 289,079 gross tons, compared with 267,022 tons in 1927, an increase of 8 per cent. Of the ferrosilicon produced in 1928, 49.8 per cent was made by the blast-furnace process, 49.9 per cent by the electric-furnace process, and a little as a by-product of the manufacture of artificial abrasives in electric furnaces. The shipments of ferrosilicon in 1928 amounted to 310,770 gross tons, or 34 per cent more than in 1927.

Ferrotungsten.—The production of ferrotungsten in 1928 was 1,872 gross tons, containing 3,254,369 pounds of tungsten (metal), an average of 77.59 per cent of tungsten. Ferrotungsten was made at 4 furnaces by 4 producers in both 1928 and 1927. The greater part of the ferrotungsten produced in 1928 was made from foreign ores, chiefly from China and Burma. The domestic ores used came mostly from California, Colorado, and Nevada, but a little ore from South Dakota and Missouri was also used.

The shipments of ferrotungsten in 1928, amounting to 1,975 gross tons, contained 3,433,832 pounds of tungsten, and the average value per pound of contained tungsten was 93 cents f. o. b. furnaces, compared with 98 cents in 1927.

Ferrovanadium.—The production of ferrovanadium in 1928 amounted to 2,019 gross tons, containing 1,692,238 pounds of vanadium (metal), an average of 37.42 per cent of vanadium. Ferrovanadium was made at 5 furnaces by 5 producers in both 1928 and 1927. The ferrovanadium produced in 1928 was made chiefly from patronite and its oxidation products from Peru, although vanadium pentoxide made from roscoelite mined in Colorado entered in appreciable amount into the output of ferrovanadium.

The shipments of ferrovanadium in 1928 were 1,895 gross tons, containing 1,590,545 pounds of vanadium, and were valued at the furnaces at an average of \$3.20 per pound of contained vanadium, as compared with \$3.19 in 1927.

IMPORTS AND EXPORTS

The imports of the alloys of the rarer metals are not all reported separately but are grouped as shown in the next table. Ferromanganese constituted the bulk of the imports in 1928; 40 per cent of it came from Canada, 33 per cent from the United Kingdom, and 25 per cent from Norway.

Prior to the tariff of September 22, 1922, the Bureau of Foreign and Domestic Commerce recorded only the gross weight of the ferroalloys imported. Since that date the import statistics are not uniform, the gross weight of some ferroalloys and the contained rarer metal of others being recorded. The reader should bear in mind

this change when comparing the quantities in the two following tables with quantities published before the change in tariff. The values, however, are comparable.

The exports of ferro-alloys are relatively unimportant. Ferro-manganese and spiegeleisen, the exports of which in 1928 were nearly six times those in 1927, constituted the greater part of the total exports in 1928.

Ferro-alloys and ferro-alloy metals imported for consumption in the United States, 1927 and 1928, by varieties

Variety of alloy	1927		1928	
	Gross tons	Value	Gross tons	Value
Ferromanganese (manganese content).....	36, 400	\$3, 553, 465	48, 844	\$4, 899, 374
Spiegeleisen.....	7, 529	220, 979	5, 260	147, 406
Ferrochrome and chromium:				
Ferrochrome—				
Containing 3 per cent or more carbon (chromium content).....	1	143	69	15, 344
Containing less than 3 per cent carbon.....	143	32, 096	611	170, 069
Chrome or chromium metal.....	10	2, 879	10	2, 508
Ferrosilicon (silicon content).....	7, 347	923, 158	4, 697	649, 739
Molybdenum and ferromolybdenum (molybdenum content).....	1	5, 712	(1)	1, 385
Titanium and ferrotitanium.....	8	3, 310	17	6, 067
Tungsten and ferrotungsten (tungsten content).....	12	10, 482	50	50, 849
Ferrovanadium.....	(2)	328	107	215, 708
		4, 752, 552		6, 158, 449

¹ 576 pounds.

² 1,058 pounds.

Ferromanganese and ferrosilicon imported into the United States, 1927 and 1928, by countries

[General imports]

Country	Ferromanganese (manganese content)				Ferrosilicon (silicon content)			
	1927		1928		1927		1928	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Canada.....	17, 923	\$2, 171, 589	19, 026	\$2, 495, 743	6, 134	\$757, 381	3, 497	\$506, 646
France.....	411	79, 842	384	63, 777	25	6, 096		
Germany.....			23	3, 477			(1)	6
Italy.....	23	3, 212	611	95, 492				
Norway.....	6, 724	537, 406	11, 896	934, 793	1, 589	261, 760	954	127, 836
Sweden.....	25	4, 909	43	5, 073	5	806		
United Kingdom.....	8, 912	608, 037	15, 567	1, 207, 830			6	1, 369
	34, 018	3, 404, 995	47, 550	4, 806, 185	7, 753	1, 026, 043	4, 457	635, 857

¹ Less than 1 ton.

Ferro-alloys and ferro-alloy metals exported from the United States, 1926-1928, by varieties

Variety of alloy	1926		1927		1928	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Ferromanganese ¹	693	\$44, 111	1, 641	\$61, 793	9, 440	\$232, 990
Spiegeleisen ¹						
Tungsten and ferrotungsten (including tungsten wire).....	13	155, 653	9	164, 917	7	123, 354

¹ Not separately classified.

STEEL

PRODUCTION

The following tables showing the production of steel were compiled by the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of the Iron Age give market quotations of prices of steel billets and some of the leading forms of finished steel. The price of Bessemer steel billets at Pittsburgh in 1928 ranged from \$32 to \$33 a gross ton; in 1927 it ranged from \$33 to \$35 a ton. Tank plates at Pittsburgh ranged from 1.81 to 1.9 cents a pound in 1928 and from 1.75 to 1.9 cents a pound in 1927. Structural shapes at Pittsburgh ranged from 1.81 to 1.9 cents a pound in 1928 and from 1.75 to 1.98 cents a pound in 1927.

Bessemer steel ingots and castings manufactured in the United States, 1924-1928, by States, in gross tons

State	1924	1925	1926	1927	1928
Ohio.....	2,557,689	2,963,590	3,035,809	2,440,235	2,577,728
Pennsylvania.....	2,210,868	2,354,231	2,420,719	2,108,483	2,293,085
Illinois.....	598,442	740,212	874,047	835,254	978,511
Other States.....	532,591	665,929	603,993	807,755	770,871
	5,899,590	6,723,962	6,934,568	6,191,727	6,620,195

Open-hearth steel ingots and castings manufactured in the United States, 1924-1928, by States, in gross tons

State	1924	1925	1926	1927	1928
New England States.....	252,273	296,091	288,533	256,716	285,767
New York and New Jersey.....	1,424,677	1,724,720	2,086,525	2,003,599	2,323,333
Pennsylvania.....	12,243,713	14,021,750	15,622,857	13,708,156	15,261,713
Ohio.....	7,119,786	8,799,951	8,628,247	8,266,708	10,179,096
Indiana.....	3,990,165	4,978,558	5,278,230	5,118,620	5,971,416
Illinois.....	2,184,068	2,817,027	2,871,688	2,741,472	3,239,669
Other States.....	4,362,668	5,396,391	5,915,899	5,973,064	6,852,962
	31,577,350	38,034,488	40,691,979	38,068,335	44,113,956

According to these tables there was an increase of 7 per cent in the production of Bessemer steel and of 16 per cent in open-hearth steel in 1928 as compared with 1927; the total production of steel increased 15 per cent. Of the total output in 1928, 85.6 per cent was represented by open-hearth steel, 12.8 per cent by Bessemer steel, and 1.6 per cent by all other classes of steel.

Of the total output of open-hearth steel, 43,200,483 gross tons were made by the basic process and 913,473 tons by the acid process, compared with 37,144,268 tons of basic steel and 924,067 tons of acid steel in 1927.

The production of steel by the electric process in 1928 showed an increase of 20 per cent as compared with 1927.

Steel electrically manufactured in the United States, 1909-1928, in gross tons

Year	Ingots	Castings	Total	Year	Ingots	Castings	Total
1909	13,456	306	13,762	1919	272,942	111,510	384,452
1910	50,821	1,320	52,141	1920	346,956	155,196	502,152
1911	27,227	1,878	29,105	1921	84,404	85,095	169,499
1912	14,147	4,162	18,309	1922	191,057	154,982	346,039
1913	20,973	9,207	30,180	1923	279,914	235,958	515,872
1914	15,458	8,551	24,009	1924	225,977	206,549	432,526
1915	46,348	23,064	69,412	1925	335,978	279,534	615,512
1916	126,048	42,870	168,918	1926	325,278	326,445	651,723
1917	239,632	64,911	304,543	1927	371,278	294,809	666,087
1918	403,068	108,296	511,364	1928	453,692	348,568	802,260

Figures for the total production of electric steel in 1928 include 433,096 tons of alloy-steel ingots and castings that were alloyed with nickel, vanadium, tungsten, chromium, molybdenum, and other metals (353,662 tons of ingots and 79,434 tons of castings), compared with 343,517 tons (284,360 tons of ingots and 59,157 tons of castings) so alloyed in 1927.

On December 31, 1928, the number of completed plants equipped for the manufacture of steel by the electric process was 225, as compared with 222 plants at the end of 1927.

Steel produced in the United States, 1810-1928, in gross tons

Year	Bessemer	Open-hearth	Crucible	Other steel	Total
1810-1870	58,482	2,232	146,370		207,084
1871	40,179	1,785	31,250		73,214
1872-1880	4,293,896	245,035	349,730	76,099	4,964,670
1881-1890	21,596,699	2,387,925	703,489	37,044	24,725,157
1891-1900	49,387,341	15,392,764	762,446	35,820	65,578,371
1901-1910	94,048,698	92,418,814	1,051,379	154,683	187,673,574
1911-1915	42,329,520	98,833,090	544,047	185,692	141,892,349
1916	11,059,039	31,415,427	129,692	169,522	42,773,680
1917	10,479,960	34,148,893	126,716	305,038	45,060,607
1918	9,376,236	34,459,391	115,112	511,693	44,462,432
1919	7,271,562	26,948,694	63,572	387,404	34,671,232
1920	8,883,087	32,671,895	72,265	505,687	42,132,934
1921	4,015,938	15,589,802	7,613	170,444	19,783,797
1922	5,919,298	29,308,983	28,606	346,039	35,602,926
1923	8,484,088	35,899,657	44,079	515,872	44,943,696
1924	5,899,590	31,577,350	22,473	432,626	37,931,939
1925	6,723,962	38,034,488	19,562	615,512	45,393,524
1926	6,934,568	40,691,979	15,493	651,723	48,293,763
1927	6,191,727	38,068,335	9,036	666,087	44,935,185
1928	6,620,195	44,113,956	7,769	802,260	51,544,180

FOREIGN TRADE IN STEEL

The following tables show the imports and exports of certain iron and steel products.

Iron and steel imported into the United States, 1926-1928

Article	1926		1927		1928	
	Gross tons	Value	Gross tons	Value	Gross tons	Value
Bar iron	5,624	\$291,239	4,226	\$193,358	2,443	\$158,014
Boiler and other plate of iron and steel	4,945	143,567	4,034	125,519	8,025	251,930
Iron and steel scrap	86,725	990,565	60,207	729,334	63,314	1,006,044
Rails for railways	55,212	1,449,178	15,455	422,832	14,019	432,452
Sheets of iron or steel, skelp, saw plates and steel, n. e. s.	10,671	563,073	15,725	773,319	22,775	1,012,477
Steel ingots, bars, etc.	30,826	1,323,522	13,672	706,295	21,439	908,538
Tin andterne plates	2,160	297,483	1,064	191,512	922	152,608
Wire and articles made from wire		5,059,623		4,135,076		4,314,378
Wire rods	10,074	691,984	18,881	942,936	19,298	1,122,409
All other manufactures of iron and steel (not specially provided for)		3,321,138		3,751,194		3,826,165

Iron and steel exported from the United States, 1927 and 1928

Article	1927		1928	
	Gross tons	Value	Gross tons	Value
Semimanufactures:				
Steel ingots, blooms, billets, slabs, and sheet bars.....	7, 053	\$392, 008	30, 101	\$1, 232, 901
Iron and steel bars and rods—				
Iron bars.....	3, 872	345, 032	6, 232	492, 477
Steel bars.....	111, 126	6, 938, 199	158, 475	9, 114, 056
Alloy-steel bars.....	6, 150	916, 389	14, 078	1, 486, 568
Wire rods.....	16, 127	883, 408	38, 623	1, 733, 693
Iron and steel plates, sheets, skelp, and strips—				
Boiler plates.....	15, 539	686, 000	9, 029	433, 476
Other plates, not fabricated.....	124, 090	6, 337, 570	161, 705	7, 966, 195
Skelp iron or steel.....	91, 561	3, 951, 879	131, 754	5, 383, 919
Iron or steel sheets, galvanized.....	152, 177	15, 498, 296	152, 228	14, 663, 965
Steel sheets, black.....	152, 523	12, 188, 391	179, 286	13, 576, 541
Iron sheets, black.....	17, 145	1, 662, 917	16, 290	1, 634, 497
Strip steel, cold rolled.....	11, 548	1, 024, 928	19, 742	1, 581, 425
Hoop, band, and scroll iron or steel.....	31, 612	2, 035, 677	38, 339	2, 397, 549
Tin plate, terneplate, and taggers tin.....	253, 888	29, 062, 466	249, 642	26, 345, 576
Manufactures—steel-mill products:				
Structural iron and steel—				
Structural shapes—				
Not fabricated.....	148, 176	6, 553, 994	202, 804	8, 753, 890
Fabricated.....	26, 084	2, 500, 271	54, 333	4, 629, 479
Ship and tank plates, punched or shaped.....	7, 037	441, 223	4, 119	319, 369
Metal lath.....	4, 663	779, 236	5, 359	830, 401
Other structural shapes.....	36, 303	2, 970, 263	34, 389	3, 163, 569
Railway track material—				
Rails for railways.....	177, 593	6, 783, 036	190, 925	6, 925, 616
Rail joints, splice bars, fishplates, and tie-plates.....	21, 403	1, 435, 750	27, 872	1, 737, 987
Switches, frogs, and crossings.....	6, 951	1, 149, 870	6, 881	1, 087, 483
Railroad spikes.....	4, 432	308, 099	4, 901	347, 530
Railroad bolts, nuts, washers, and nut locks.....	1, 585	261, 526	2, 333	309, 786
Tubular products—				
Boiler tubes.....	14, 713	1, 741, 090	18, 749	2, 300, 509
Casing and oil-line pipe.....	95, 764	9, 317, 963	119, 784	11, 399, 020
Welded black pipe.....	92, 149	7, 856, 224	74, 730	6, 323, 985
Welded galvanized pipe.....	45, 847	4, 383, 567	35, 576	3, 302, 976
Malleable-iron screwed pipe fittings.....	10, 064	3, 086, 111	10, 108	2, 857, 330
Cast-iron screwed pipe fittings.....	7, 253	1, 505, 903	7, 288	1, 347, 804
Cast-iron pressure pipe and fittings.....	11, 601	1, 235, 102	9, 944	913, 670
Cast-iron soil pipe and fittings.....	9, 121	694, 908	16, 632	1, 088, 137
Wire and manufactures—				
Barbed.....	47, 296	3, 155, 854	69, 198	4, 376, 680
All other.....	57, 384	7, 703, 609	69, 023	8, 671, 697
Nails and bolts (except railroad)—				
Cut nails.....	1, 148	103, 455	1, 296	113, 217
Horseshoe nails.....	1, 079	267, 082	1, 145	279, 466
Wire nails.....	9, 991	762, 518	14, 546	955, 722
All other nails, including tacks and staples.....	6, 203	1, 284, 693	7, 452	1, 291, 605
Bolts, nuts, rivets, and washers (except railroad).....	12, 228	2, 196, 261	13, 280	2, 538, 754
Castings and forgings—				
Horseshoes.....	575	90, 699	468	73, 302
Iron and steel, including car wheels and axles.....	40, 255	5, 261, 615	50, 631	7, 685, 217
Advanced manufactures:				
House-heating boilers and radiators.....		902, 457		711, 793
Tools—				
Axes.....		1, 034, 195		1, 129, 294
Hammers and hatchets.....		370, 485		341, 102
Saws, wood and metal cutting.....		1, 996, 429		2, 105, 579
Shovels and spades.....		416, 962		357, 961
All other tools.....		12, 663, 209		13, 540, 001

CHROMITE

By LEWIS A. SMITH ¹

INTRODUCTION

Rapid expansion in the consumption of chromium, begun in 1922, continued in 1928, and present indications are for continued increase in consumption. The most noteworthy developments in 1928 included the extensive adoption of chromium plating, especially for automobile parts; the increased utilization of rustless iron and steel and nickel-chromium steel; and the further substitution of chromite refractories for magnesite refractories, due to a favorable price differential. The tanning industry appears to be turning more and more toward chromium reagents. The demand for chromium pigments seems to have been maintained.

Shipments of chromite from mines in the United States in 1928 were more than three times those in 1927, but were still relatively insignificant. Favorable development of the large chromite deposits of Southern Rhodesia continued in spite of the lack of adequate transportation, and a record output of 195,918 long tons was made in 1928. Plans have been made for improvement of the transportation facilities before the end of 1929. The rapid development of the Transvaal chromite area was a leading event in the Union of South Africa in 1928. This field is said to rival the Rhodesian fields, as it is favored by lower freight costs to exporting points. Further discoveries of chromite have been made in Canada and Indo-China, the latter being the more important at the present stage of development, although of lower grade. In New Caledonia the development of electric smelting of nickel ores has increased the demand for chromite refractories for furnace linings. Some believe that the famous Tiébaghi mine can no longer furnish the same volume of high-grade ore it once did, but active development of other properties in New Caledonia may offset decreased production from this mine. The promising Baluchistan deposits of British India continued to develop favorably, and the Soviet trusts were actively engaged in an attempt to rehabilitate the Ural chromite industry. The deposits of the Shetland Islands, Scotland, first opened early in the nineteenth century, are still working, and the concentrated product appears to be suitable for pigment manufacture. In Turkey the United Swedish Steel Works Co. has acquired concessions in the Eskishehir, Kosfindik, and Ecrenos areas and is doing development work; the Brusa deposits have been assigned to a Turkish company on a 60-year basis; and a British firm (Peterson & Co.) controls one of the large deposits of Smyrna. The Turkish production in 1928 was nearly twice that in 1927.

¹ Statistics on domestic production prepared by H. M. Meyer and data on imports compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the Bureau of Mines

The development of successful electric smelting methods for making stainless steels direct from chromite and iron ore may lead to a solution of the metallurgical difficulties in attempting to handle the chromiferous nickel iron ore deposits of the lateritic type. The known reserves in these deposits are so large that they indicate a source upon which a stable and lasting industry might be built. It has been conservatively estimated that the reserves of this material in Cuba, Celebes Island, Greece, Borneo, Indo-China, South Africa, and the Philippines would reach 5,000,000,000 tons.

CHROMITE MINING IN THE UNITED STATES

In the United States 368 long tons of chromite were mined during 1928, and 660 tons were shipped, compared with 50 tons mined and 201 tons shipped in 1927. Ore was mined in 1928 in Mendocino, San Luis Obispo, and Shasta Counties, Calif.; in Harford County, Md.; and in Stillwater County, Mont. On the line between Shasta and Trinity Counties, Calif., near Castella, Gibson, and La Moine is a group of small deposits which was producing during the latter half of 1928; S. Gallgos has a 25-ton crushing plant at Gibson and is said to have shipped five carloads of chromite up to the middle of August. During the World War most of the domestic chromite produced was obtained from the California deposits. The extensive chromiferous serpentine area in Stillwater and Sweet Grass Counties, Mont., has only been prospected on the east and west ends, where promising deposits have been shown. Published statements concerning one property indicate that it may be developed to the point of shipping concentrates during 1929. This region has been described in part by S. G. Westgate in United States Geological Survey Bulletin 725, pages 67 to 84. Further prospecting work in this area may disclose new and valuable deposits.

The following table shows the quantity of crude chromite mined and the quantity and value of that shipped from mines in the United States from 1923 to 1928, by States.

Crude chromite mined and shipped from mines in the United States, 1923-1928, by States

State	Ore containing 45 per cent or more of chromic oxide			Ore containing 35 to 45 per cent of chromic oxide			Total value
	Mined (long tons)	Shipped (long tons)	Value	Mined (long tons)	Shipped (long tons)	Value	
1923							
California	69	60	\$1,415				\$1,415
Maryland	90	80	1,840				1,840
Montana				22			
Oregon	78	78	564	313			564
	237	227	3,819	335			3,819
1924							
California	213	188	940				940
Montana				20			
Oregon					1 100	1 \$200	1 200
	213	188	940	20	1 100	1 200	1 1,140

¹ Ore from Oregon in 1924 contained less than 35 per cent Cr₂O₃.

*Crude chromite mined and shipped from mines in the United States, 1923-1928,
by States—Continued*

State	Ore containing 45 per cent or more of chromic oxide			Ore containing 35 to 45 per cent of chromic oxide			Total value
	Mined (long tons)	Shipped (long tons)	Value	Mined (long tons)	Shipped (long tons)	Value	
1925							
California.....	83	83	\$1, 650				\$1, 650
Maryland.....	25	25	455				455
Oregon.....				47			
Washington.....	2						
	110	108	2, 105	47			2, 105
1926							
California.....	127	47	957		44	\$22	979
Maryland.....	67	50	1, 100				1, 100
	194	97	2, 057		44	22	2, 079
1927							
California.....	50	² 201	² 5, 063				² 5, 063
1928							
California.....	152	206	3, 392	179	446	11, 250	14, 642
Maryland.....	12	8	165				165
Montana.....				25			
	164	214	3, 557	204	446	11, 250	14, 807

² According to the quarterly report of the Division of Mines and Mining, Department of Natural Resources, California, April, 1923, p. 161, which states that 225 short tons (201 long tons) of chromite were sold in 1927. No shipments for 1927 were reported by the producers to the Bureau of Mines.

IMPORTS

The United States imported 216,592 long tons of chromite during 1928, a decrease of 5,768 tons from the 222,360 tons imported in 1927. In 1927 the United States imported 55 per cent of the total world production, but in 1928 only about 49 per cent of the probable world output of about 442,000 tons. Southern Rhodesia, exporting through Portuguese East Africa, again furnished more than half of the total United States imports; the quantity imported from this source in 1928 was 112,073 long tons, or nearly 17,000 tons less than in 1927. Cuba, British India, Greece, Union of South Africa, and New Caledonia each furnished more than 15,000 tons, and smaller amounts were obtained from Brazil, Cyprus, Turkey, and the Netherlands. The decrease in imports from Rhodesia is believed to be due to the accumulation of considerable stocks in 1927 by consumers, which protected the industry from irregular deliveries caused by transportation difficulties. Cuban imports nearly doubled as a result mainly of operations by the Bethlehem Steel Corporation in Cuba; these ores are suitable for the manufacture of refractory materials. The New Caledonia ore is best fitted for chemicals and pigments because of its comparative purity.

The following tables show the imports of crude chromite and chromium products into the United States over a series of years.

Crude chromite imported into the United States, 1923-1928, in long tons

[General Imports]

Country	1923	1924	1925	1926	1927	1928	
						Quantity	Value
Africa:							
British—							
East.....			678	1,000			
South ¹	52,153	21,642	18,463	17,794	¹ 6,935	¹ 15,745	¹ \$119,494
Portuguese—							
East ²	15,591	37,152	70,718	105,022	² 128,851	² 112,073	² 703,365
Other.....		26,287	6,805	7,724		4,000	30,154
Brazil.....				1,840	729	320	9,600
Canada.....	3,401						
Cuba.....	10,420	8,145	29,830	36,020	16,983	33,707	278,345
Greece.....	10,550	13,390	12,533	21,065	22,527	17,152	166,952
Guatemala.....				53			
India (British).....	29,238	7,335	8,360	13,800	13,572	17,591	245,419
Japan.....			300				
Malta, Gozo, and Cyprus.....						600	7,126
Netherlands.....						50	425
Oceania (French).....	7,410	4,392	2,032	11,146	11,500	15,154	141,649
Turkey in Asia.....						200	2,459
United Kingdom.....	(³)		20				
	128,763	118,343	149,739	215,464	222,360	216,592	1,704,988

¹ Recorded as Union of South Africa for 1927 and 1928.

² Recorded as Mozambique for 1927 and 1928.

³ Quantity not recorded.

Ferrochrome or ferrochromium, chrome or chromium metal, and chromium vanadium imported for consumption in the United States, 1924-1928, in long tons

	1924	1925	1926	1927	1928
Ferrochrome or ferrochromium:					
Containing 3 per cent or more of carbon (chromium content).....	30	69	15	1	69
Containing less than 3 per cent of carbon, gross weight.....	436	588	495	143	611
Chrome or chromium metal.....	2	3	1	10	10
Chromium vanadium.....		32	20		

Chromium compounds imported for consumption in the United States, 1919-1928

Year	Chromic acid			Chromate and bichromate of potash			Chromate and bichromate of soda			Chromium chloride and sulphate		
	Pounds	Value		Pounds	Value		Pounds	Value		Pounds	Value	
		Total	Average		Total	Average		Total	Average		Total	Average
1919.....				15,450	\$4,271	\$0.28				(¹)	(¹)	(¹)
1920.....	1,100	\$90	\$0.08	4,414	2,690	.61				(¹)	(¹)	(¹)
1921.....	1,969	674	.34	73,011	6,772	.09	64,236	\$5,308	\$0.08	(¹)	(¹)	(¹)
1922.....	4,663	1,289	.28	8,584	1,676	.20	22,731	1,540	.07	(¹)	(¹)	(¹)
1923.....	4,632	2,026	.44	5,563	1,033	.19	245	73	.30	2,771	\$654	\$0.24
1924.....	32,493	2,484	.08	10,486	1,924	.18				9,095	1,340	.15
1925.....	5,564	2,216	.40	4,379	778	.18	221	46	.21	3,520	941	.27
1926.....	7,220	2,892	.40	8,177	1,449	.18	220	44	.20	1,810	693	.33
1927.....	15,620	9,755	.62	5,007	906	.18	330	67	.20	40,650	2,419	.06
1928.....	99,617	24,547	.25	6,866	1,112	.16	1,752	287	.16	110	33	.30

¹ Not separately classified prior to change in tariff, Sept. 22, 1922. None recorded Sept. 22 to Dec. 31, 1922.

CONSUMPTION

Owing to lack of data concerning consumers' stocks it is not possible to give figures covering the consumption of chromite in the United States. The following table, however, gives the apparent available supply (imports plus domestic production), from 1919 to 1928, by years.

Domestic sales, imports, and supply of chromite in the United States, 1919-1928

Year	Sales from domestic mines			Imports (general)			Apparent available supply		
	Long tons	Value		Long tons	Value		Long tons	Value	
		Total	Average		Total	Average		Total	Average
1919	5, 079	\$129, 302	\$25. 46	61, 404	\$1, 381, 497	\$22. 50	66, 483	\$1, 510, 799	\$22. 72
1920	2, 502	44, 857	17. 93	150, 275	1, 921, 824	12. 79	152, 777	1, 966, 681	12. 87
1921	282	2, 900	10. 28	81, 836	654, 602	8. 00	82, 118	657, 502	8. 01
1922	355	7, 288	20. 53	90, 081	741, 186	8. 23	90, 436	748, 474	8. 28
1923	227	3, 819	16. 82	128, 763	1, 123, 120	8. 72	128, 990	1, 126, 939	8. 74
1924	288	1, 140	3. 96	118, 343	1, 095, 603	9. 26	118, 631	1, 096, 743	9. 24
1925	108	2, 105	19. 49	149, 739	1, 207, 420	8. 06	149, 847	1, 209, 525	8. 07
1926	141	2, 079	14. 74	215, 464	1, 704, 947	7. 91	215, 605	1, 707, 026	7. 92
1927	¹ 201	¹ 5, 063	25. 19	222, 360	1, 748, 598	7. 86	222, 561	1, 753, 661	7. 88
1928	660	14, 807	22. 43	216, 592	1, 704, 988	7. 87	217, 252	1, 719, 795	7. 92

¹ According to the division of mines and mining, department of natural resources, California.

USES

METALLURGICAL

The largest use of chromite in the United States is in the manufacture of ferrochrome, which in turn is used in the preparation of alloy steels and castings.

Alloy steels.—The nickel-chromium alloys are among the most important of the alloy steels because of their high tensile strength, ductility, and resistance to abrasion and to corrosion by atmospheric and chemical agencies and by heat. In these alloys probably 30 per cent of the nickel and 50 per cent of the chromium consumed in the United States are used. The following table shows the approximate range in composition of some of the common alloy steels.

Group	Composition, per cent					
	Iron		Chromium	Nickel	Carbon	Silicon
A ¹	96	-98. 5	0. 5- 1. 25	1- 2. 5	0. 1-0. 5	
B	20	-60	7. 5-40	20-65	. 3 - . 6	0. 3-0. 5
C	68. 8-74. 8		17 -20	7-10	. 16- . 25	. 5

¹ The chromium to nickel ratio is usually 1 to 2-2.5.

Because of its resistance to abrasion and corrosion group A finds application in grinding machinery, excavating buckets, automobile parts requiring good tensile strength and abrasion resistance, and similar apparatus. Alloys of group B are generally classified as heat-resisting alloys; these are used in furnace parts and in machinery that must resist the action of hot gases, slags, and other corrosive agencies.

Group C has the greatest potential utilization because of the resistance of these alloys to corrosion or tarnish by atmospheric agencies, acids, and salt water. "Stainless" steels are now being used extensively in ships for pumps, tubing, armor plate, etc.; in cutlery; in oil and gas cracking plants at refineries; and in many automobile parts. It is the hope of some manufacturers of stainless steel that the cost will be reduced eventually to a point at which competition may be given to galvanized iron. The Swedish Forsbacka Iron Works is said to have made stainless steels at a relatively low cost direct from chromite and iron ores by the Flodin-Gustavson electric-furnace method. Several American companies have acquired the right to manufacture under the Krupp "Nirosta" (group C) patents in the United States. The 15 new cruisers to be built in the next three years will probably use a large quantity of alloys of groups A and C.

In addition to the chromium-nickel alloys there are straight chromium steels, which usually contain 12 to 18 per cent of chromium and about 0.1 per cent of carbon. Because of their resistance to wear and corrosion these compete with the stainless steels, which contain nickel as well as chromium.

A new product, "Nitalloy," which has been developed recently by Dr. Leon Guillet, of Paris, promises to find special application in automobile-engine cylinders because of its hardness and its ability to take a high polish. The composition parallels that of group A but with aluminum substituted for nickel. Experiments indicate the possibility that this alloy may become a substitute for bronze and babbitt bearings.

The chromium-vanadium steels are used as spring steels and in the larger parts of locomotives and other machinery requiring very high tensile strength. The chromium is included in these alloys to improve their resistance to fatigue and to corrosion.

Alloy castings.—During 1928, according to the March 28, 1929, issue of *Iron Age*, 271,000 long tons of iron-alloy castings were made in the United States by about 3,900 foundries; the larger part of this production contained chromium or nickel, or both metals. Chromium-iron castings resist abrasion, many corrosive agencies, and heat; these castings contain 22 to 28 per cent of chromium and 0.5 to 3 per cent of carbon and may contain some nickel, vanadium, or tungsten where special qualities are desired.

Nickel-chromium iron and steel, which are among the most important of the alloy castings, are used in automobile parts, tractors, and other apparatus requiring good wearing qualities. Such castings usually contain 1.5 to 2.5 per cent of nickel, 0.5 to 1.25 per cent of chromium, and 0.2 to 0.5 per cent of carbon, a composition similar to that of group A of the alloy steels.

REFRACTORIES

The second largest use of chromite is in the manufacture of refractories; this industry consumes approximately 40 per cent of the chromite used in the United States. In 1928 the increased production of chromite refractories is believed to have resulted from a cost differential favoring chromite brick over magnesite brick. The chemical and physical requirements of chromite refractories were summarized in the chapter of this series in *Mineral Resources of the United States, 1927, Part I*, pages 314 to 315.

CHEMICALS

Most of the chromite that enters the chemical industry is used in the manufacture of sodium and potassium bichromate, which in turn are the basis for the production of chromic acid, basic chromium sulphate, chromium pigments, and many other less important chemicals. The principal uses of this group of chemicals are in the tanning, electroplating, pigment, dyeing, and printing industries. A noteworthy increase in consumption of bichromates was made in the last half of 1928 as the result of increasing demand by domestic and foreign consumers, despite reported increase in the cost of manufacture. Small stocks were carried by consumers toward the end of 1928. Several American manufacturers own chromite mines in New Caledonia and are in an independent position with respect to their supply of raw material. Up to the last few years chromic acid had slight commercial importance, because its use was limited. The development of chromium-plating processes, in which chromic acid plays an important rôle, has brought this acid into prominence. During 1927, according to the January (1929) issue of Chemical and Metallurgical Engineering, the domestic production, as indicated by the amount offered for sale, was 898,093 pounds, valued at \$241,965; during 1928 new producers entered the field and a substantial increase in output resulted, the amount of which is not yet known.

Discussion of some of the more important chemical uses of chromium follows.

Chromium plating.—The use of chromium in the electroplating industry was increased substantially during 1928. Because of its hardness, resistance to corrosion and tarnish, bright silver luster, and high reflectivity chromium plate is rapidly replacing nickel plate, especially in the automotive industry, where it was widely adopted in 1928. The use of chromium plate is also being rapidly extended to plumbing fixtures, builders' hardware, soda fountain equipment, coffee colanders, silverware, guard rails, and the metal-novelty trade, where its silvery luster and nontarnishing qualities make it very valuable. Chromium plate has recently been applied successfully to engraving plates, gauges, tools, and dies, where its hardness is of chief value. During 1928 in Pacific coast oil refineries it was found that the use of chromium plate reduced the corrosion of cracking chambers treating high sulphur oils. Likewise, in the paper industry the life of tubes used for the evaporation of waste sulphate liquor has been increased considerably by plating the tubes with chromium. Although it is true that chromium plate is rapidly replacing nickel plate, it can not be said that chromium prospers at the expense of nickel, since it has been found that more satisfactory chromium coatings on steel are obtained if a coat of nickel is applied first. As the more durable properties of chromium develop a much wider field of usefulness than that of nickel alone, the increased utilization of chromium for plating tends on the whole to increase, rather than diminish, the requirement for nickel. The increasing demand for chromium-plated articles has resulted in improved technology, and one of the most important developments in the industry during 1928 was the reduction of costs through the installation of automatic equipment and the increase in the size of the plating units. Voltages were lowered to 6 volts or less and current densities decreased to 75

amperes per square foot. The expansion of the chromium-plate industry in Europe is evidenced by the fact that in Germany 23 new plating works have been established since 1925.

Tanning.—Chromium tanning has developed rapidly during recent years, and most of the light-colored leather is now tanned by the use of chromium salts. The reagent most commonly used is basic chromium sulphate, which is usually prepared from sodium bichromate.

Pigments.—The principal chromium pigments are chrome yellow and chrome green. Chrome yellows are compounds of lead and chromic acid; they vary in color according to composition, chrome orange being one of the more important varieties of the yellow. The market for chrome yellow during 1928 was unsettled because the declining lead market caused fluctuating prices for lead required in pigment manufacture during the early part of the year. Chrome green is a mixture of chrome yellow and Prussian blue and is marketed as "c. p." and as "commercial," the latter containing fillers such as barite and silica. Chrome green c. p. was the outstanding green pigment during 1928; the price, which was speculative for several years, has been stable at 27 cents a pound since January, 1927. During 1927, according to the Bureau of the Census, the production of chrome yellow, chrome green, and chrome orange amounted to 33,100,880 pounds; data on 1928 production are not available. Other chrome pigments, of minor importance, are chrome red, zinc chromate, barium chromate, and chrome oxide green.

SECONDARY CHROMIUM

A possible source of secondary chromium is indicated in the following quotation:²

It may be news to some metal men that a chromium by-product is readily obtainable in large quantities from chemical works operating certain organic chemical reactions. Manufacturers of dyestuffs, for instance, are frequently glad to get rid of the crude chrome alum which results from the oxidation of anthracite used as one of the starting points in their works, and it is a great pity for this valuable source of chromium metal not to be fully exploited.

The necessary steps are comparatively simple in character, as will be immediately realized. Chrome alum consists in common parlance of double sulphate of chromium and potassium. The chromium can be precipitated in the form of the hydroxide or a mixture of hydroxide and oxide by pumping ammonia gas through, or else by boiling it in order to hydrolize any chromites which may be formed by treating the chrome alum with sodium or potassium hydroxide. The precipitate is then removed by rapid mechanical filtration, dried, and then ignited to remove any combined water that may be present, and subsequently it is mixed with carbon and reduced in electric furnaces in the usual way.

MARKETING CHROMITE

The following quotation³ summarizes the requirements of various industries using chromite.

Most buyers of chrome ore are satisfied if the chrome and iron contents are stated, though sometimes the percentages of silica or alumina are also desired. Buyers for the steel or ferro-alloy industries usually desire an ore containing not less than 45 per cent chromic oxide and an iron content not exceeding one-quarter of the combined iron and chromic oxide. For instance, if the chromic oxide content is 45 per cent, the iron must not exceed 15 per cent. The chemical

² Ellis, E. T., *By-Products and the Metal Trades: The Metal Industry*, Sept. 14, 1928, p. 245.

³ Eng. and Min. Jour., vol. 125, No. 12, Mar. 24, 1928, p. 501.

trade requires the chromic acid content to be 50 per cent or better, but is not so particular about the iron content, and the limit already given might be exceeded by 1 or 2 per cent. Manufacturers of refractories demand low silica, generally below 5 to 8 per cent.

Ore of low chromic acid content is acceptable to the ceramic and brick industry, though, of course, it does not command so high a price. As low as 38 per cent chromic acid is quite commonly accepted, and business has been done in even lower grades when the shipping facilities from mine to consumer were particularly advantageous, so that an unusually low price could be quoted.

No recognized standard exists for premiums and penalties. In sales to the steel and chemical trades it is customary to quote a price per ton based on a definite percentage of chromic oxide—say, 20 dollars for 50 per cent material with an allowance of 40 cents for each unit above or below this analysis. The brick and refractory trades, however, buy ordinarily as is, with a guaranteed minimum content of chromic acid and with no premium for a better quality than is specified.

PRICES

The quoted price ⁴ for 45 to 50 per cent Rhodesia and India ores, c. i. f. Atlantic ports, was \$22.50 to \$23 a long ton during January and February, during March and April there was a slight rise to \$22.50 to \$23.50. May, June, July, August, and September prices held constant for Rhodesia and India ores, but in July the specifications were changed to 47 to 50 per cent Cr_2O_3 . In October specifications were changed again, and India and Rhodesia ores of 47 to 49 per cent grade were quoted at \$21 outright, while 50 to 51 per cent ores commanded \$23. In November India and Rhodesia 47 to 49 per cent ores rose to \$22, the other prices remaining the same as in October. There was no change in December prices. New Caledonia high-grade ore was quoted at \$25 per ton, f. o. b. eastern ports. According to the Iron Trade Review, the price for Rhodesia and India ores for the year was \$22 to \$24.

Ferrochromium remained constant throughout the year at 60 to 70 cents per pound of contained chromium, spot shipments demanding an additional one-half cent.

Chromite bricks were steady at \$45 a long ton in spite of increasing demand.

WORLD PRODUCTION

The estimated world production of chromite in 1928 was about 449,000 metric tons, an increase of 41,000 tons over 1927. The production in Rhodesia increased slightly to 199,060 metric tons in 1928 and was about 44 per cent of the estimated world output. The exports from New Caledonia in 1928 were 56,698 metric tons, compared with 42,885 tons in 1927. Practically all Cuban production is shipped to the United States; imports from Cuba into the United States amounted to 34,248 metric tons in 1928, compared with 17,256 tons in 1927. Production in Greece in 1928 is reported as 20,953 metric tons, but imports into the United States from Greece, which usually account for a large part of the actual Grecian output, decreased 24 per cent in 1928. The Union of South Africa produced 31,756 metric tons in 1928. Brazil, India (British), Japan, Russia, Turkey, United States, and Yugoslavia also contributed to the world total; the figures for three of these countries are not yet available.

⁴ Engineering and Mining Journal, weekly quotations.

The following table shows the world production of chromite from 1924 to 1928.

Production of crude chromite, 1924-1928, by countries, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924	1925	1926	1927	1928
Australia.....	785	978	607		
Brazil ¹			1,500	1,820	20
Cuba.....	² 19,881	³ 30,309	³ 36,598	³ 17,256	³ 34,248
Cyprus ¹	2,856	2,021	524	711	
Great Britain.....	1,060	455		384	
Greece.....	14,651	8,079	20,049	17,314	20,953
Guatemala ³			54		
India (British).....	46,192	38,053	33,918	58,125	(⁴)
Indo-China.....	20				
Japan.....	5,362	5,823	7,052	9,782	(⁴)
New Caledonia.....	23,021	34,732	34,267	¹ 42,885	56,902
Norway ¹	177	440	17		(⁴)
Rhodesia, Southern.....	156,692	123,220	164,376	197,782	199,060
Russia ⁵	11,894	30,111	30,362	19,294	(⁴)
Turkey (Asia Minor).....	3,400	6,667	6,445	16,609	12,039
Union of South Africa.....	4,572	13,756	12,042	16,959	31,756
United States (shipments).....	293	110	143	204	671
Yugoslavia.....	300	12,160	15,983	8,757	16,678
	291,156	306,914	363,937	407,882	⁶ 449,000

¹ Exports.

² Production of the Caledonia mine.

³ Imports into the United States.

⁴ Data not available.

⁵ Data for year ended Sept. 30.

⁶ Partly estimated.

WORLD ASPECTS

From a world-wide view of the chromite situation, considering past production, consumption, prices, potential production, and producing capacity, the deposits of Rhodesia, India, Union of South Africa, Turkey, Greece, and New Caledonia appear capable of supplying the world demand with ease for many years.

The following countries have produced and shipped chromite during or since the World War.

Australia:	Guatemala.	Rhodesia, Southern.
New South Wales.	India (British).	Rumania.
Queensland.	Indo-China.	Russia.
Brazil.	Japan.	Turkey (Asia Minor).
Canada.	New Caledonia.	Union of South Africa.
Cuba.	Norway.	United States.
Cyprus.	Portugal.	Yugoslavia.
Great Britain.		
Greece.		

The following list names the countries where chromite is known to occur but from which there is no record of recent shipments.

Algeria.	Czechoslovakia.	Newfoundland.
Argentina.	Egypt.	New Zealand.
Australia:	French West Africa	Palestine.
Tasmania.	(Guinea).	Persia.
Victoria.	Germany.	Portuguese Timor.
Western Australia.	Greenland.	Spain.
Austria.	Italy.	Sweden.
British East Africa	Mexico.	Syria.
(Uganda Protectorate).	Netherland East Indies	Togoland.
Chosen.	(Celebes).	

CHROMIFEROUS NICKEL IRON ORES

Rapid expansion in the consumption of chromium-nickel steel alloys and advancement being made in this branch of metallurgy may help to solve the economic problem of utilizing chromiferous nickel iron ore deposits of the lateritic type, consisting of particles of chromiferous material concentrated in place by the weathering of outcrops; the known reserves in these deposits are very large. It has been estimated that the reserves of Cuba can be conservatively figured at 3,000,000,000 tons and those of the Celebes Island at 1,400,000,000 tons, while the known deposits of Greece, Borneo, Transvaal, and the Philippines are of considerable importance.

SUMMARY OF PRODUCTION AND CONDITIONS IN THE PRINCIPAL CHROMITE-PRODUCING REGIONS OF THE WORLD

CANADA

Chromite is found in Quebec in the counties of Brome, Megantic, Richmond, Wolfe, and Gaspé, the ore occurring as lenses in serpentine. Being of low grade, it requires concentration. Chromite is also found in British Columbia, on Scottie Creek, Bonaparte River, 18 miles north of Ashcroft, in dikes and veins in volcanic rocks. A deposit⁵ was recently discovered south of Collins Station on the Canadian National Railroad west of Armstrong, Ontario, where the ore occurs in a dike 700 feet wide and about 1¼ miles long; two samples sent to the Ontario Department of Mines ran 28.86 per cent and 39.23 per cent Cr_2O_3 , respectively. At Port Arthur⁶ diamond drilling has disclosed considerable chromite in the Shebandowan nickel ore deposits of the Sudbury Basin Mines Co. (Ltd.). Disseminated low-grade mineralization over a width of 60 feet was disclosed. The similarity of these formations, both in structure and mineralization, to those of the Bushveld Complex in South Africa suggests that chromiferous deposits of the type found in Southern Rhodesia and Transvaal may be encountered in Canada.

CUBA

The imports of chromite from Cuba into the United States, which represent practically the entire output of Cuba, amounted to 33,707 long tons in 1928, nearly double those of 1927. The output of Cuba is produced by the Bethlehem Steel Co., the Cuban Industrial Ore Co., and E. J. Lavino & Co. (of Wilmington, Del.), the Bethlehem Steel Co. handling the larger part. As there was some shipment from stocks on hand, exports probably exceeded production. It is said that one of the companies shipped 3,047 long tons of chromite which had been produced at the Caledonia mine, near Mayari; this mine was idle during 1928. At Camaguey the Bethlehem Steel Co. mined 22,306 long tons of chromite and shipped 25,486 tons to Sparrows Point, Md., through Puerto Tarafa on the north coast of Cuba. The ore from Caledonia averaged 42 per cent Cr_2O_3 and that from Camaguey 33 per cent. On December 31, 1927, stocks on hand at Caledonia amounted to 14,186 tons and at Camaguey to 5,068 tons,

⁵ Skilling's Mining Review, Oct. 13, 1928, p. 8.

⁶ Skilling's Mining Review, Feb. 9, 1929, p. 6.

whereas stocks on hand December 31, 1928, were 11,139 and 1,888 tons, respectively. In Cuba large deposits of chromiferous iron ore have been known for some time; these ores might be utilized in the manufacture of chromium steel should an economic process for handling them be developed. The principal deposits of chromiferous iron ore are on Moa Bay, Province of Oriente, and in the Province of Puerto Principe; they occur as segregations in gabbro rocks, cutting serpentines.

The Cuban Industrial Ore Co. and E. J. Lavino & Co. were the main producers in the Alta Gracia district on the Nuevitas-Camaguey Railway. The Bethlehem Cuba Iron Mines Co. opened a mine near Alta Gracia and produced some chromite.

GREECE⁷

The chromiferous iron ores of Greece are of considerable importance; the principal deposits are in Thessaly and in the Khalkidike Peninsula. In some years as much as 15,000 tons of ore has been mined. The ore occurs in irregular masses in serpentines and other ultrabasic rocks. The irregular nature of these deposits has made exploitation sporadic. The principal mine in Thessaly is close to Pharsala, 30 miles west of Volo, the port from which Thessalian ore is shipped to Belgium and the United States; within recent years this mine has produced annually more than 10,000 tons of 38 to 40 per cent ore. Another important mine in Thessaly is the Alchani Domokos; in 1927 it produced considerably more than the Pharsala mine. On the south side of Lake Daoukli at Nezero is a smaller mine close to the main railroad line from Larissa to Lamia; numerous smaller deposits occur in the Neochori district on the western slope of the Othyris Mountains, at Voivoda, near the narrow-gauge railroad from Kalabaka to Volo. A number of comparatively small workings are found in Macedonia, 20 miles west of Salonika, near Katerini, where the ore occurs as segregations in serpentine derived from peridotites. Ore bodies of similar nature occur in places on the Khalkidike Peninsula. The mine at Vavdos near Glatista has an average annual output of 300 tons. Deposits have been reported in several parts of Euboea and Boeotia and from the Island of Skyros.

Chromite produced in Greece in 1927, by companies and by districts^a

Company	District	Ore mined	Ore in stock	Chromic oxide
		<i>Metric tons</i>	<i>Metric tons</i>	<i>Per cent</i>
Apostolides Frères.....	Pharsala.....	5,616	635	38-40
Nicolas Zitouniatis.....	Nezero.....	100	-----	33.00
George E. Polygenis.....	Ardouan.....	1,465	-----	38-40
Société Union Minière.....	Alchani Domokos.....	9,630	428	40-41
E. Loutsis.....	Ineli (Larissa).....	250	-----	(^b)
Vordonis, Ieropaes, Mithos.....	Daitsa.....	253	-----	40.91
Soc. de Recherches et de Travaux Miniers.....	Vavdos.....	-----	-----	-----
		17,314	1,063	-----

^a Statistique de l'Industrie Minière de la Grèce, 1927, Athens, 1928, pp. 10-11.

^b Not given.

⁷ Wray, D. A., Greece: Its Geology and Mineral Resources: Min. Mag. (London), vol. 40, No. 2, 1929, p. 90.

INDIA (BRITISH)

The production of chromite in India ⁸ was 57,207 long tons in 1927, compared with 33,382 tons in 1926, an increase of 23,825 tons or 71 per cent. The following table shows the production in India in 1926 and 1927, by States and by districts.

Chromite produced in India, 1926-27, by States and by districts

State and district	1926		1927	
	Long tons	Value	Long tons	Value
Baluchistan: Zhob.....	14, 832	£16, 247	14, 534	£16, 270
Bihar and Orissa: Singhbhum.....	1, 623	2, 763	2, 552	3, 689
Mysore State:				
Hassan.....	10, 827	7, 248	34, 030	36, 423
Mysore.....	6, 100	4, 552	6, 091	9, 361
	33, 382	30, 810	57, 207	65, 743

The Hassan district produced more than three times as much chromite in 1927 as in 1926, while Singhbhum showed a smaller increase and Mysore and Zhob small decreases.

Exports from British Indian ports were 31,200 long tons in 1928, compared with 20,996 tons in 1927; most of the ore exported was shipped to France, the United States, and the United Kingdom. In addition, a considerable tonnage of ore produced in British India was exported through the port of Mormugão, Portuguese India. Such exports amounted to 21,957 tons in 1927 and 10,337 tons in 1926.

During the fiscal year ended June 30, 1927, a large number of chromite leases (covering 6,711 acres) were in force in British Baluchistan, and 14,832 tons of ore was produced, even though many of the mines did not work continuously.

The Singhbhum ⁹ deposits of Bihar and Orissa were first noted by Saubolle between Chiabasa and Sonua in 1907. No large bodies were disclosed; comparatively little work has been done on these deposits, although the commercial possibilities are said to be promising. The annual output has never exceeded 3,300 tons (3,266 in 1917). The ores, some of which contain as much as 53 per cent Cr_2O_3 , occur in a series of ultrabasic igneous rocks. The principal mines are the Roro-Chitung, Bongamunda, and KK₂-Kadans, a large part of the ore from these mines averaging about 44 per cent. Lessees do the mining by crude and costly methods. Mining costs around \$3 a ton and transportation to the nearest railroad at Chiabasa about \$3.40 a ton.

The Mysore deposits occur in veins in serpentine dikes in a dunite series of Archean rocks.

The Salem deposits reveal chromite in veins associated with magnesite, the whole formation belonging to the dunite series.

The price quotations for India ore, ¹⁰ c. i. f. United Kingdom ports, ranged in January from 95 to 100 shillings (\$23 to \$24.50) ¹¹ per long

⁸ Fermor, L. L., The Mineral Production of India during 1927: Records India Geological Survey, vol. 61, 1928, Calcutta, p. 210.

⁹ Mahadevan, C., The Chromite-Bearing Ultrabasic Deposits of Singhbhum: Eeon. Geol., vol. 24, No. 2, 1929, pp. 195-205.

¹⁰ Rhodesian Chamber of Mines monthly statements for January to November, 1928, inclusive.

¹¹ Reckoned on pound at \$4.85 and shilling at 24¼ cents.

ton. Prices rose in June to 105 to 110 shillings (\$25.50 to \$26.70), where they remained throughout the remainder of the year.

INDO-CHINA¹²

Extensive deposits of low-grade ore in Indo-China, recently described, occur 25 kilometers southwest of Thank-Hoa (Annam) in the valleys dividing the slopes of mountains Nui-Na-Son and Nui-Nua. A survey of these deposits completed in 1924 showed alluvial material from the test pits containing 11.6 to 22 per cent Cr_2O_3 . The deposits are estimated to contain 1,700,000 tons of ore, which can easily be mined and milled.

NEW CALEDONIA¹³

La Société la Tiébaghi, a British firm, and La Société Chimique de Chrome, an American firm, are the two main companies producing chromite in New Caledonia. The Tiébaghi mine, on the north end of the island, is one of the richest and most important mines in the world. It has produced over 1,200,000 tons of ore to date, and present reserves indicate an equal production in the future, but of a lower grade. During 1927 and early 1928 the Tiébaghi company carried out a large development program and at the same time doubled its facilities for handling ore. Plans call for further increases which will permit the loading of a ship a month. The American company is operating mines at Nehoue and Pagoumene on the west coast, and the Alpha and Fantouche mines; these properties produce about 1,500 tons of chromite per month.

New Caledonia exported 56,698 metric tons of chromite during 1928, compared with 42,885 tons in 1927. The following table shows exports of chromite from New Caledonia from 1924 to 1927, by countries of destination.

Chromite exported from New Caledonia, 1924-1927, by destinations, in metric tons

Destination	1924	1925	1926	1927
Austria.....	1, 181	3, 007	1, 252	1, 840
Belgium.....	1, 995	6, 609	5, 093	2, 258
England.....	7, 112	-----	2, 540	-----
France.....	2, 463	3, 856	1, 350	8, 081
Germany.....	-----	-----	-----	3, 556
Holland.....	-----	-----	-----	12, 245
United States.....	2, 540	4, 064	9, 292	14, 905
	15, 291	17, 536	19, 527	42, 885

RHODESIA

Rhodesia supplies nearly 50 per cent of the world output of chromite and in 1928 produced 195,918 long tons, an increase of 1,259 tons over 1927. The ore shipped in 1928 averaged 47 to 50 per cent Cr_2O_3 . The following table, giving the production of chromite in Rhodesia from 1907 to 1928, shows the rapid increase made in output.

¹² South African Mining and Engineering Journal, vol. 39, pt. 2, Johannesburg, Sept. 29, 1928, p. 122.

¹³ Roberts, Quincy, Commerce of New Caledonia: Consular Rept. 290,392 (8073), Suva, Fiji Islands, Sept. 17, 1928.

*Chromite produced in Rhodesia, 1907-1928*¹

Year	Long tons	Value	Year	Long tons	Value
1907.....	10, 415	£30, 842	1918.....	27, 934	£134, 857
1908.....	11, 927	37, 024	1919.....	31, 502	142, 541
1909.....	22, 875	60, 420	1920.....	53, 812	245, 378
1910.....	39, 288	98, 132	1921.....	44, 811	195, 360
1911.....	46, 753	116, 905	1922.....	83, 460	302, 880
1912.....	61, 839	154, 600	1923.....	86, 317	244, 582
1913.....	56, 504	141, 481	1924.....	154, 218	432, 482
1914.....	43, 042	107, 612	1925.....	121, 274	337, 317
1915.....	54, 089	175, 792	1926.....	161, 780	420, 334
1916.....	79, 349	333, 170	1927.....	194, 659	490, 653
1917.....	65, 145	327, 347	1928.....	195, 918	471, 668

¹ Rhodesian Mining Journal, vol. 3, No. 21, Johannesburg, February, 1929, p. 71.

By far the greater part of the output comes from the large Selukwe deposits, while Lomagundi, the Umvukwes, and Mashonaland contribute smaller amounts. These deposits are located along the "Great Dyke" in the south central part of Southern Rhodesia.

The principal producing companies in 1928 were the Edmond Davis, Rhodesia Chrome & Asbestos, Mann, Little & Co., and the Becker Trust Co. The outstanding event during 1928 was the consolidation of the Edmond Davis and the Rhodesia Chrome & Asbestos groups, by which their holdings in the Umvukwes were merged, giving the new holding company, the African Chrome Mines Co., control of the major part of the output from Rhodesia. Mann, Little & Co., new producers in the Umvukwes, have two subsidiaries—the Great Southern Rhodesia Chrome Co. and the Great Western Chrome Co. (Ltd.); this group produces high-grade ore in Rhodesia and low-grade ore in Transvaal.

The Selukwe deposits were first developed in 1906 by the Rhodesia Chrome Co. Part of this district is connected with the main railway system by a narrow-gauge line about 12 miles long. The ore is transported by rail to Beira, in Portuguese East Africa, whence it is shipped to foreign countries. The principal mines include the Selukwe Peak, Railway Block, Iron Peak, and Iron Ton.

The Lomagundi district has been so hampered by poor transportation facilities that production represents only about one-fourth of the capacity of the field. Conservative estimates indicate that, with adequate rail connections, the field could produce 10,000 to 15,000 tons yearly.

The Umvukwes and Darwendale areas have recently been discussed as follows:¹⁴

From the figures obtained the writer has conservatively estimated that 200,000 tons of chromite are available for every 100 feet in incline depth from each mile from north to south of the Great Dyke. In other words, taking the average width of the Great Dyke as $2\frac{3}{4}$ miles, an average of 200,000 tons of chromite can be obtained from every $2\frac{3}{4}$ square miles of the Great Dyke rock, no mine working exceeding 100 feet in inclined depth.

As the depth of 100 feet is purely arbitrary, the tonnage to be produced is capable of great expansion if mining to greater depth be economically justified.

That the above estimate is conservative is shown by a statement made by a chromite producer in the Southern Umvukwes that he obtained 1,500 tons from each block of claims, no working exceeding 12 feet in depth. This is equivalent

¹⁴ Keep, F. E., Interim Report on the Geology of the Chromite Deposits of the Umvukwe Range, Lomagundi District: So. Rhodesia Geol. Surv. Short Rept., No. 23, Salisbury, 1928; quoted in Mining Magazine (London), vol. 40, No. 3, March, 1929, pp. 180-181.

to over 125,000 tons per square mile to a depth of 100 feet, or approximately 344,000 tons to $2\frac{3}{4}$ square miles to a depth of 100 feet. It must be borne in mind, however, that the latter tonnage is probably only obtainable from selected blocks, whilst the writer's estimate is an average for a very large area. * * *

* * *. The question of the economic value of the chromite deposits of the Umvukwes is bound up with two things: (1) markets, (2) transport.

At the present time mining costs in those areas between the Umvukwes and Darwendale, in which chrome is being produced, are said to vary between 12s. and 14s. per ton of 2,240 pounds, inclusive of loading wagons or lorries for transport to the railway. The former figure is for shallow surface work, down to 12 feet in depth, whilst a chromite seam 30 inches in thickness has been mined to an inclined depth of 450 feet at a cost of 14s. per ton.

Transport costs vary from 7d. to 9d. per ton-mile, several large producers paying, at the present, between 14s. and 17s. per ton for road transport by ox-wagon or motor lorry between the mine and the railway.

It naturally follows that the question of the economic depth to which mining can be carried out depends largely upon the distance between the mine and the nearest loading station on the railway, a decrease in road transport costs resulting in a huge tonnage of previously useless chromite becoming of economic value.

The author summarizes his conclusions as follows:

1. The chromite seams were formed by a process known as "Magmatic segregation."
2. The seams will extend to depth.
3. No general change in the character of the seams will be found at depth.
4. Minor faulting will complicate mining to a certain extent.
5. At least 200,000 tons of chromite ore can be produced from each $2\frac{3}{4}$ square miles of Great Dyke rock for every 100 feet incline depth in the area dealt with.
6. The grade of the ore to be produced will be well above the lowest market requirements.
7. The future of the deposits depends on the capacity of the markets to absorb a largely increased production of chromite.

Much interest is now being shown in the Mashonaland chromite areas,¹⁵ which promise to become of importance in the African situation. These deposits are richer but less massive than the Selukwes or Umvukwes. The principal mines are the "Peaks Chrome," "Lone Cow," and "Sheila's Luck," the latter having been acquired recently by the Rhodesia Asbestos & Chrome Co. Altogether some 2,716 claims, covering an area of about 20 square miles, have been posted by this company. American interests are prospecting this field, and recently the British firm of Mann, Little & Co. acquired 148 blocks through its subsidiary, the Great Southern Rhodesia Chrome Co. At least four chromite seams have been found, on both sides of the "Great Dyke" and ranging from tiny stringers to deposits a foot or more thick. Analyses of 74 samples indicate that the ore will probably average 50 per cent Cr_2O_3 and that a fairly large amount will reach 52 to 54 per cent. Costs range around 8s. 6d. for delivery at Banket Station (10 to 15 miles from the mines) and 74s. 6d. landed in Europe; this cost could be reduced materially if the railway were extended to the fields. About 1,000,000 tons has been developed thus far down to 100 feet in depth.

On the whole, the situation in Rhodesia may be summarized by saying that the reserves are enormous, and that the ore is favorably received in world markets. Some competition may be expected from Turkey and India, but the deposits in those countries are less extensive and no more accessible. With adequate transportation facilities, Rhodesia could probably supply the world need for many years.

¹⁵ The South African Mining and Engineering Journal, vol. 39, pt. 2, Johannesburg, Feb. 9, 1929, p. 599.

RUSSIA

Russia produced 19,294 metric tons of crude chromite in the fiscal year ended September 30, 1927, compared with 30,362 tons in the year ended September 30, 1926, a decrease of more than 11,000 tons. Figures for 1928 are not yet available. The following table shows the production of chromite in Russia from 1923 to 1927, by districts.

*Chromite produced in Russia in years ended September 30, 1923-1927, by mines or by districts, in metric tons*¹

Mine or district	1923	1924	1925	1926	1927
Saranov deposits.....		1, 673	11, 319	11, 621	7, 847
Alapaevsk deposits.....	131	914	4, 212	3, 048	1, 442
Kutuzovsk mine.....		770	3, 374	1, 067	
Gologorsk mine.....	744	2, 628		5, 947	2, 830
New Business mine.....		2, 154	2, 386	4, 472	266
Khaeilovsk deposits.....		1, 638	3, 384	2, 223	3, 041
Kairaktinsk deposits.....			2, 916		
Other mines in Urals.....	17	2, 117	2, 520	1, 984	2, 634
	892	11, 894	30, 111	30, 362	² 18, 060

¹ 1923-1926, Russia, Geol. Committee, Annual report on the mineral resources of the U. S. S. R. during the fiscal year 1925-1926, Leningrad, 1927, pp. 775-782; 1927, Gornyi Zhurnal, vol. 104, No. 9, Moscow, 1928.

² Total revised to 19,294 tons in later issue of annual report of Geological Committee; details not given.

The following companies produced chromite during the year ended September 30, 1927. Total revised later to 19,294 tons, but details by companies not given.

	Metric tons
Alapaevsk Trust.....	1, 442
Gornet Trust.....	252
Ural Iron Ore District Trust.....	7, 847
Southern Ural Trust.....	1, 750
Beloretzky Mining Trust.....	632
Orengub Syndicate.....	3, 041
Northern Chemical Trust.....	3, 096
	18, 060

The Saranov deposit¹⁶ is said to contain 690,000 metric tons of chromite averaging 35 to 40 per cent chromic acid; the Alapaevsk-Goroblagodat deposit, about 1,000,000 tons of mixed grades; the Gologorsk, about 117,000 tons of 44 per cent ore; and the Karabutak deposits, around 120,000 tons of 40 to 42 per cent ore. The South Ural district is said to have numerous small mines scattered over an area 70 kilometers long and 3 to 5 kilometers wide, and the ore is said to be of comparatively high grade.

The main developments during 1928 centered around the Poldnevskaya, Ufaleyskaya, Polevskaya, Nizhne-Isetsk, Beresov, Kasly, Kyshtym, Mramorsky, and Verkh-Neivinsk deposits. These mines are all situated in the North Ural district, and some of them were worked before the World War.

The Verkh-Neivinsk¹⁷ district has been the most important producer in the Urals and has furnished a substantial part of the total output from Russia since late in the nineteenth century. The ore was shipped to Ushkov and used in the manufacture of chemicals and ferrochrome. The production for the 10 years before the World

¹⁶ Work cited, pp. 775-782.

¹⁷ Gornyi Zhurnal, vol. 104, No. 7, Moscow, July, 1928, pp. 531-532.

War was around 31,000 tons, but subsequently there was little activity until 1927. Twenty-five per cent of the ore formerly mined ran 48 to 50 per cent Cr_2O_3 ; 50 per cent averaged 40 to 46 per cent; and the remainder averaged from 36 to 40 per cent. The mining cost in recent years has been about \$4 a ton. There are about 10 mines, some of which have fairly substantial reserves.

The Poldnevskaya deposits¹⁸ have reserves of 30,000 tons of ore, running from 44 to 46 per cent Cr_2O_3 ; they were being developed extensively during 1927 and 1928.

The Ufaleyskaya¹⁸ and the Polevskaya¹⁸ deposits were being developed in 1928, and a total reserve of more than 120,000 tons was reported. The ore averages 30 to 48 per cent Cr_2O_3 , and additional large tonnages of concentrating ore averaging below 30 per cent have been disclosed.

The Nizhne-Isetsk and Beresov¹⁹ deposits are said to contain 22,800 tons of proven ore; in addition, 52,000 tons of ore is reported as probably available and 48,000 tons as possibly available. It is estimated that more than 70 per cent of the reserves will average better than 40 per cent Cr_2O_3 . The yearly output in recent years has been around 1,000 tons averaging 48 to 50 per cent Cr_2O_3 . These, like the other Ural deposits, have large tonnages of lower-grade ore which will probably be found amenable to concentration.

The Mramorsky¹⁹ district has a fairly large tonnage running 42 to 47 per cent Cr_2O_3 reported as possible of development as ore. The Kasly and Kyshtym deposits have a total reserve around 60,000 tons, 70 per cent of which will average about 40 per cent Cr_2O_3 . This ore contains 5 to 10 per cent of silica and is believed to be a fair refractory material.

The Soviet Government is doing a considerable amount of work in the Urals, with the apparent aim of establishing a chromite industry which will at least supply the domestic market. Some ore was exported during 1927 and 1928. In 1927 the major part of the Russian production came from the Urals, and the remainder was obtained from the Bashkirian Republic.

SHETLAND ISLANDS²⁰

The chromite deposits of the Shetland Islands have been exploited since 1818, when considerable quantities of ore were shipped to England for use in the manufacture of pigments. The deposits are in the form of veins or lenses in dunite-serpentine rocks. Quarries 60 feet wide have been worked near Queyhouse and at Hagdale to a depth of about 86 feet, below which the grade of the ore has been disappointing. Some production has been made from the veinlike deposits at Baltasound. Interesting minerals found in these deposits include mitchellite (magnochromite), containing 40 per cent Cr_2O_3 ; white picotite, which yields only 8 to 10 per cent Cr_2O_3 ; and gradations between chromite and picotite. The best ore runs 17.52 per cent FeO , 23.74 per cent Al_2O_3 , 44.56 per cent Cr_2O_3 , 11.09 per cent SiO_2 , and 1.29 per cent CaO . Some analyses show low silica and very high magnesia (16.6 per cent) content. In the Nikka Vord quarries a

¹⁸ Gornyi Zhurnal, vol. 104, No. 10, Moscow, October, 1928, pp. 744-746.

¹⁹ Gornyi Zhurnal, vol. 104, No. 6, Moscow, June, 1928, pp. 437-440.

²⁰ Hitchen, C. Stansfield, Unst and Its Chromite Deposits: Mining Mag. (London), vol. 40, No. 1, January, 1929, pp. 13-24.

beautiful chrome-chlorite, kämmererite, occurs along fissures in the ore. A concentrating plant with a capacity of 20 tons in 10 hours has been in operation in the last few years, and small tonnages have been shipped each year. From ore averaging 8 to 10 per cent Cr_2O_3 a concentrate running 32 to 34 per cent has been produced; this has been used in the manufacture of chromite brick. In 1920, 900 tons of concentrates were produced, but since then a total of only 1,650 tons has been shipped. Further activity is anticipated as a result of the increasing market for chromium products.

TURKEY

Turkish chromite deposits, long known, again have attracted considerable attention. Deposits are now worked in the Makri area, west of Adalia, by the French Société Minière de Féthie. The Sud-Anatolische Bergbau A. G. also operates in this area, but as a result of agreements with the French company it is producing manganese only.²¹ The Roechling group is working the Dagħ Ardy deposits, the annual output of which is about 14,000 tons of high-grade ore. This region should be benefited by the better transportation facilities to be afforded by the completion of the railway from Taushanli to Kutachia. The Kuzludya and Karlyer deposits, originally owned by the Krupp Co., are not very active. Eighteen workable deposits of ore are reported in the vicinity of Adalia. The ore is said to average about 50 per cent Cr_2O_3 . Between Adalia and Alaya is another chromite area containing 16 located deposits, on which no serious work has been done as yet. A practically untouched chromiferous area lies near Eskishehir, where about a dozen deposits have been located. The ore is said to run from 43 to 50 per cent Cr_2O_3 . The United Swedish Steel Works Co. has concessions on two of these deposits and is now investigating other areas near Eskishehir, Kosfindik, and Erenos. Similar deposits near Brusa have been assigned to a Turkish company for 60 years. A British firm (Peterson & Co.) owns the best deposits in Smyrna.

Forty years ago Turkey produced more than half the world's supply of chromite, but recently the large output from the enormous deposits of Rhodesia, New Caledonia, and India has reduced Turkey's chromite industry to a subordinate position. Operations in the Turkish chromite areas are at present hindered by poor transportation facilities, but it is believed that the situation will be much improved by the completion of the Kutahya-Taushanle railway.

UNION OF SOUTH AFRICA

Production of chromite in the Union of South Africa is confined to Transvaal. In 1928, 27,971 long tons of ore was shipped, as compared with 15,163 tons in 1927. The future of Transvaal as a factor in the world situation is believed by some to be very bright, as indicated by the following quotation:²²

The export of chrome ore from Rhodesia has already established itself as a sound and profitable branch of mineral industry, and in recent years Southern Rhodesia has assumed the leading place in the list of world producers. We have felt and stated, for some time past, that the Transvaal was destined to secure an

²¹ American Metal Market, Dec. 21, 1928.

²² The South African Mining and Engineering Journal, vol. 39, pt. 2, Johannesburg, Feb. 9, 1929, p. 599.

important share in the world's chromite trade. The development of our very large resources must naturally take some time, but we have now reached the position where the future is definitely assured. As we noted last week, the value of our exports rose from £24,939 in 1927 to £35,265 in 1928. During 1928 contracts already entered into call for the shipment of approximately 50,000 tons of Transvaal chromite, and during the present month it is anticipated that over 6,000 tons will be railed from Boshhoek and Steelpoort to Lourenco Marques.

The general quotations for Rhodesian and Transvaal chrome ores are, respectively, 90s. to 95s. per ton, 48 per cent minimum, and 60s. per ton, 42 per cent minimum, c. i. f. in each case. Expressed on the usual unit basis, Transvaal ore costs the European or American user 1s. 6d. per unit as against 2s. per unit for the Rhodesian material, both prices being c. i. f. at his nearest port. As usual, the higher grade ore commands the better price. The future of Transvaal ore, therefore, depended upon the ability of the user to apply the cheaper unit to his process without modification of plant or method and without material increase in process cost.

Fortunately for Transvaal chromite, its chemical and physical properties permit the attainment of such a result. Trial shipments have proved, particularly, so far, to numerous German users that Transvaal ore requires no appreciable alterations in method, and that the overall cost of using it is less than the corresponding cost of applying Rhodesian ore. Consequently, these users have entered into contracts for their future requirements, running into considerable tonnages.

Meanwhile a similar educational process is being carried out in the United States, and several big users there are approaching the point where they can with confidence make similar provision for the future. On the whole, therefore, the outlook has so far developed that those who are in intimate touch with the business venture to prophesy that in five years' time exports of Transvaal chromite will reach a figure of 200,000 tons and possibly top the quarter-million mark in 1935. While there is no suggestion made that the Transvaal will put Southern Rhodesian chromite out of business, or, with the evergrowing demand for chromium, seriously reduce the present rate of production, it is clear that such a rate of increase in Transvaal exports will make this province a very important factor in the trade. If these prophecies were in due course fulfilled, we would expect a move in the direction of a big African chromite combine for the better regulation of the trade and the maintenance of prices and markets.

The principal working deposits are at Boshhoek and Steelpoort, in the Rustenburg district. The ore seams range from 3 to 5 feet in width and can be mined more cheaply than the relatively narrow seams in Rhodesia. The ore is delivered by rail 430 miles to Lourenco Marques in the southern part of Portuguese East Africa for shipment to Europe and the United States. Mann, Little & Co., through its subsidiary, the Great Western Chrome Co. (Ltd.), has been the prime mover in developing this area. The Becker Trust Co. has been delivering some chromite from its Steelpoort property.

YUGOSLAVIA

Before 1925 the recorded annual chromite production of Yugoslavia did not exceed 300 tons. In 1926 the output was 15,983 metric tons, but in 1927 production declined to 8,757 tons; the 1928 production was 16,678 tons. The chapter of this series for 1927 gives some details of the industry in Yugoslavia.

ANTIMONY

By PAUL M. TYLER ¹

STATISTICAL SUMMARY

Summary of statistics for antimony in the United States, 1926-1928

	1926	1927	1928
Average price for year of antimony at New York.....cents per pound..	15. 91	12. 34	10. 30
Imports for consumption:			
Antimony in ore.....short tons..	1, 559	2, 015	2, 185
Metal.....do.....	11, 506	9, 891	9, 684
Exports of foreign antimony.....do.....	184	363	599
Stocks of antimony in bonded warehouse at end of year.....do.....	962	1, 773	1, 471
Production of antimony ore.....do.....	99	-----	86
Antimony contained.....do.....	43	-----	42
Production of antimonial lead (from domestic and foreign ores).....do.....	22, 524	24, 347	33, 058
Antimony contained.....do.....	2, 683	2, 736	3, 432
Recovery of secondary antimony.....do.....	16, 230	12, 400	11, 900

INTRODUCTION

In 1928 the apparent consumption of antimony declined further, continuing the trend of the previous year when the demand for new metal for use in radio and automobile storage-battery plates first began to drop. As market quotations for antimony are notoriously subject to violent fluctuations it is noteworthy that prices in 1928 were relatively stable. Stocks were normal at the end of the year.

Shipments of antimony from China to the United States increased in 1928, as compared with those in 1927. Total imports of antimony metal or regulus into the United States from all sources declined slightly in 1928, but this decline was partly offset by an increase in imports of needle antimony. In Mexico production increased 86 per cent. Bolivia exported 5,834 metric tons of ore, containing 3,543 tons of metallic antimony, or an average of 60.72 per cent; the recoverable metal content of the ore exported is given as 2,834 metric tons in 1928, compared with 3,214 tons in 1927.

¹ Unless otherwise stated, statistics in this report were prepared by H. M. Meyer, and data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the Bureau of Mines.

A number of small shipments of antimony ore were made in 1928 from American mines and prospects. As usual, however, the domestic output of antimony was derived mainly as a by-product of lead smelting.

MARKETS AND PRICES

Very little primary antimony is produced in the United States, except in antimonial lead at lead smelters. A large part of the domestic antimony supply is imported in the form of metallic antimony, but substantial quantities of the element are imported in other forms, including liquated antimony sulphide, antimony ore, antimonial lead, and oxide of antimony. Only small quantities of other salts or compounds are imported. Metallic antimony is still known in the trade as regulus, but this archaic term is less commonly used now than it was even a few years ago. Liquated sulphide is variously known as crude antimony, needle antimony, and antimony matte, and, like the metal, it is imported chiefly from China. It is used principally in the manufacture of oxide. A little antimony ore is imported from Argentina, Bolivia, and Mexico, and is used by primary lead smelters and secondary smelters for making antimonial lead. High-grade ore instead of crude antimony may be used for the manufacture of oxide. An Australian report states that there is an assured market in the United States for 60 per cent stibnite ore to the extent of 5,000 tons annually. Antimonial lead is an alloy containing from 12 to 20 per cent antimony. Antimony oxide is imported chiefly from China.

According to Furness:²

About 90 per cent of the antimony metal imported into the United States is sold as Chinese antimony, guaranteed minimum 99 per cent pure. There are a few special brands of antimony which have higher guaranties as to quality and for which buyers pay a premium ranging approximately from one-half to 5 cents a pound. However, these special brands amount only to about 10 per cent of the total imports of the United States. The metallic antimony trade is handled mainly through agents, importers, and brokers. Prices are generally quoted either c. i. f. New York in bond, or duty-paid f. o. b. New York, or ex-dock or warehouse New York, either in bond or duty-paid. Antimony is sold on the basis of price per pound, the same as copper, lead, and tin; it is seldom that there is any dispute regarding quality, as Chinese antimony invariably runs 99 per cent pure or better. In England, the price is in pounds sterling per long ton. Terms are net cash against documents. Whenever there is any controversy regarding quality it is the custom of the trade to employ Ledoux & Co. (Inc.), New York assayers, to sample and assay the shipment involved and to arrange for adjustment on the basis of its findings.

Chinese antimony is packed in standard cases weighing 224 pounds net, each case containing 6 or 7 pigs weighing from 30 to 40 pounds each. English regulus comes in casks containing 672 pounds. It is customary for buyers to accept foreign standard weights as final. No samples are taken in order to determine the grade of the shipments; the metal is judged by its appearance. A clean slab of antimony shows a crystalline form on the exposed side, known to the trade as "star" or "star antimony." The method of determining the purity of the metal by its appearance is one of custom, as it is possible to produce a metal of superior quality without starring, and also an inferior metal may be starred.

² Furness, J. W., *The Marketing of Antimony: Trade Inf. Bull. 624*, Bureau of For. and Dom. Commerce, 1929, p. 24.

For 30 years, ended 1914, the average price of English (Cookson's) antimony was 7.5 cents a pound and for minor brands about 6 cents. Shortly after the Russo-Japanese War, however, the price rose above 26 cents. As a result of an embargo placed on exports from England during the World War, Cookson's quotations ceased in May, 1915. Chinese brands reached a peak of 46 cents a pound in March, 1916.

Prices of antimony (Chinese brands) per 100 pounds at New York City, 1913 and 1920-1928¹

Year	High	Low	Average	Year	High	Low	Average
1913-----	\$9. 250	\$6. 250	\$7. 520	1924-----	\$14. 125	\$8. 375	\$10. 836
1920-----	11. 375	5. 750	8. 485	1925-----	20. 250	11. 250	17. 494
1921-----	5. 500	4. 500	4. 957	1926-----	23. 750	9. 500	15. 988
1922-----	7. 000	4. 250	5. 471	1927-----	15. 000	10. 750	12. 393
1923-----	9. 250	6. 350	7. 897	1928-----	11. 375	9. 500	10. 305

¹ Compiled from Engineering and Mining Journal.

According to H. P. Henderson,³ the price of antimony oxide varies according to whiteness, grade, and purity. Current published quotations for Chinese white antimony oxide at the end of 1928 were 15½ cents per pound; but Chinese antimony oxide could be purchased at 5 or 6 cents per pound below the published quotation, which, however, corresponds to that for the better grades of antimony oxide imported from Europe.

Antimony ores are quoted in English trade journals. For 50 per cent ores the price in 1928 was 5s. (\$1.20) per long-ton unit, and for 60 per cent ores it was 5s. 9d. to 6s. (\$1.40 to \$1.45) per long-ton unit.

PRODUCTION

There was a small domestic production of antimony ore in 1928. Domestic lead ores yielded a considerable tonnage of antimonial-lead alloy as a by-product of lead smelting, and foreign ores yielded an additional quantity of a similar by-product. This material was used as a substitute for antimony in making bearing metal, type metal, and like products. The production of antimonial lead from domestic ores in 1928 was 17,930 short tons, with an antimony content of 2,105 tons, and from foreign ores it was 15,128 tons, with an antimony content of 1,327 tons. The recovery of antimony from old alloys, scrap, and dross in 1928 was 11,900 short tons.

In 1927 antimony ore carrying approximately 35,000 pounds of pure metal was produced as a by-product from concentrates of certain of the lode mines in the Fairbanks district of Alaska. These concentrates were shipped to an American smelter for treatment. A considerable body of high-grade antimony ore was reported to have been discovered in the fall on claims on Cleveland Peninsula, in the Ketchikan district, southeastern Alaska, where the presence of rich antimony ore has been known for several years. Engineers

³ Tariff Readjustment, 1929, Hearings Before the Committee on Ways and Means, House of Representatives, 70th Cong., 2d sess., vol. 1, 1929, pp. 314-315.

were reported to have made an examination late in the 1927 season of certain antimony prospects in the Kantishna district in the interest of an English firm.⁴

The world production of metallic antimony in 1928 was probably around 30,000 short tons. Of this quantity the United States consumed somewhat more than one-third, judging from its imports. In recent years world consumption has fluctuated between 20,000 tons in times of small demand and 50,000 tons in war time.

Mine production of antimony ores in the United States, 1919–1928, in short tons

Year	Ore	Antimony content	Year	Ore	Antimony content
1919–1921.....			1925.....	123	33
1922.....	20	4	1926.....	99	43
1923.....	40	10	1927.....		
1924.....	113	33	1928.....	86	42

SMELTEER PRODUCTION OF ANTIMONIAL LEAD

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1919–1928

Year	Short tons	Antimony content		Year	Short tons	Antimony content	
		Short tons	Value ¹			Short tons	Value ¹
1919.....	13, 874	1, 943	\$319, 000	1924.....	20, 787	2, 763	\$596, 800
1920.....	12, 535	2, 033	345, 000	1925.....	19, 667	2, 624	918, 400
1921.....	10, 064	1, 589	158, 000	1926.....	22, 524	2, 693	856, 400
1922.....	8, 075	1, 441	156, 000	1927.....	24, 347	2, 736	675, 800
1923.....	14, 190	2, 170	338, 500	1928.....	33, 058	3, 432	707, 000

¹ Calculated at average yearly price for ordinary brands of antimony as given by American Metal Market.

RECOVERY OF SECONDARY ANTIMONY

During 1928 (according to J. P. Dunlop) the recovery of antimony from old alloys, scrap, and dross was 11,900 short tons. Of this total 11,155 tons was recovered in the form of alloys and 745 tons as metallic antimony; 1,355 tons was recovered from antimonial-lead scrap treated at regular smelters, and 10,545 tons was recovered as metal and in alloys at secondary smelters.

Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1919–1928

Year	Short tons	Value ^a	Year	Short tons	Value ^a
1919.....	4, 399	\$717, 900	1924.....	9, 404	\$2, 025, 600
1920.....	5, 600	938, 560	1925.....	10, 840	3, 794, 000
1921.....	4, 720	464, 400	1926.....	16, 230	5, 164, 400
1922.....	7, 090	765, 700	1927.....	12, 400	3, 060, 300
1923.....	8, 021	1, 252, 800	1928.....	11, 900	2, 451, 400

^a Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

⁴ Smith, Philip S., Mineral Industry of Alaska in 1927: U. S. Geol. Survey Bull. 810-A, 1929, pp. 62–63.

The lead and, to a large extent, the antimony that enter the storage-battery industry are reused over and over. Battery plates contain up to 6 or 7 per cent of antimony, but because of the admixture of lead oxide and various impurities the material returned to secondary smelters ordinarily contains under 4 per cent of antimony; the lead content averages 75 per cent. The scrap and old plates from electric storage batteries are bought by eastern smelters on the basis of current metal prices and of actual analysis (wet assay minus 1½ per cent). The smelting charge varies, but \$30 a ton may be considered typical.

The antimony and lead in cable sheathings also periodically reappear upon the market. An idea of the importance of antimony in cable sheathings is given by a recent statement of the American Telephone & Telegraph Co. in connection with its 1928 construction program. This statement says that approximately 1,370 miles of cable, containing more than 680,000 miles of wire, was installed, involving the use of 346,000 pounds of antimony, together with 34,000,000 pounds of lead and 31,000,000 pounds of copper.

IMPORTS AND EXPORTS

Antimony imported for consumption in the United States, 1919-1928

Year	Antimony ore ¹			Liquated antimony sulphide ²		Metallic antimony ³		Antimony oxides and other compounds ⁴	
	Short tons	Antimony content		Short tons	Value	Short tons	Value	Short tons	Value
		Short tons	Value						
1919.....	993	409	\$54,477	278	\$19,202	7,159	\$1,021,587	126	\$9,501
1920.....	1,709	682	70,285	1,375	123,902	9,817	1,216,376	298	25,260
1921.....	213	98	11,682	353	17,577	10,130	784,146	154	15,558
1922.....				689	40,108	9,344	659,242	379	65,538
1923.....	(5)	1,047	44,721	835	64,493	6,763	641,804	2,277	288,206
1924.....	(5)	899	62,999	558	52,393	6,778	840,434	1,207	190,252
1925.....	1,359	773	47,084	760	115,990	9,857	2,362,915	1,792	349,990
1926.....	2,497	1,559	287,258	2,040	343,705	11,506	3,144,330	2,259	517,584
1927.....	3,566	2,015	282,098	1,077	134,949	9,891	2,111,411	1,803	484,873
1928.....	3,912	2,185	313,127	1,208	158,231	9,684	1,641,265	2,643	448,156

¹ Classified in tariff classification as "Antimony ore and stibnite containing antimony."

² Classified in tariff classification as "Antimony matte containing not more than 10 per cent of lead," also as "Needle or liquated antimony."

³ Classified in tariff classification as "Antimony regulus or metal."

⁴ Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

⁵ Figures not available.

Antimony imported into the United States, 1927-28¹

[General imports]

Country	Antimony ore			Antimony metal ¹	
	Gross weight (short tons)	Antimony content		Short tons	Value
		Short tons	Value		
1927					
Argentina.....	91	49	\$5,385		
Austria.....				83	\$19,124
Belgium.....				22	5,948
Bolivia ³	28	17	2,725		
Canada.....				(⁴)	47
Chile ³	1,880	1,159	108,082		
China ⁴				9,900	1,948,474
France.....				97	23,241
Germany.....				1,054	227,927
Greece.....	36	20	943		
Japan ⁴				34	8,091
Mexico.....	1,429	710	157,304	564	116,246
Netherlands.....				84	19,462
Peru.....	47	27	3,909		
United Kingdom.....				532	147,791
	3,511	1,982	278,348	12,370	2,516,351
1928					
Argentina.....	544	354	40,185		
Belgium.....				992	155,317
Bolivia ³	254	147	16,365		
Canada.....				(⁴)	31
Chile ³	1,498	898	107,512		
China ⁴				8,096	1,252,727
Germany.....				395	71,747
Hong Kong ⁴				56	9,324
Mexico.....	1,467	694	138,952	1,574	269,551
Netherlands.....				22	4,088
Peru.....	149	92	10,113		
United Kingdom.....				214	57,242
	3,912	2,185	313,127	11,349	1,820,027

¹ Includes large quantities of antimony metal that went into bonded warehouse and that are not included in the table of imports for consumption.

² Includes small quantities of liquated antimony sulphide, known in the trade as "crude antimony," "antimony matte," or "needle antimony."

³ Imports credited to Chile originated mainly in Bolivia.

⁴ Nearly all the imports of antimony ore and metal from Hong Kong and Japan are of Chinese origin. Some of the material credited to other countries is possibly also of Chinese origin, having been transhipped in a foreign port.

⁵ Less than 1 ton.

Type metal¹ imported for consumption in the United States, 1919-1928

Year	Type metal		Assumed antimony content		Year	Type metal		Assumed antimony content	
	Short tons	Value	Short tons	Percentage		Short tons	Value	Short tons	Percentage
1919.....	6,697	\$816,642	1,197	17.9	1924.....	² 644	² \$100,367	(³)	(³)
1920.....	14,944	1,349,495	2,063	13.8	1925 ¹	3,005	463,134	850	28.3
1921.....	19,485	1,191,553	4,132	21.2	1926 ¹	4,311	912,331	784	18.2
1922.....	22,448	1,120,814	5,476	24.4	1927 ¹	439	65,049	106	24.1
1923.....	² 3,677	² 431,610	(³)	(³)	1928 ¹	1,995	193,177	452	22.6

¹ Classification for 1925 to 1928 is "Type metal and antimonial lead"; separate figures not recorded.

² Lead content only. Figures for gross weight for 1923 and 1924 not available.

³ Data not available.

*Foreign antimony (matte, regulus, or metal) exported from the United States, 1919-1928*¹

Year	Short tons	Value	Year	Short tons	Value
1919 ²	215	\$33,913	1924.....	140	\$14,441
1920.....	448	51,607	1925.....	94	17,376
1921.....	150	15,741	1926.....	184	41,554
1922.....	19	1,548	1927.....	363	72,280
1923.....	8	1,047	1928.....	599	90,975

¹ During 1922 there was also exported, mainly to Canada, 112 tons of regulus or metal of domestic manufacture, valued at \$13,961. This is the first export of domestic antimony of which there is any record. However, antimony manufactured in the United States from foreign ores and exported would also be classed as domestic exports. Similar exports for 1923-1928 are not shown.

² Also 3 short tons of antimony ore, containing 5,380 pounds of antimony, valued at \$1,665, was exported in 1919.

METALLURGICAL DEVELOPMENTS

A study of the physical and chemical properties of the higher oxides of antimony is being conducted at the Bureau of Mines experiment station at the University of California, Berkeley, Calif. The behavior of these oxides is important in relation to certain problems in refining virgin lead and in working up antimonial scrap lead recovered after use in storage batteries. Although the trioxide of antimony is volatile at relatively low temperatures, the tetroxide is practically nonvolatile, and the pentoxide decomposes with an evolution of oxygen. The inertness and nonvolatility of the tetroxide are undoubtedly responsible for the occasionally anomalous behavior of antimony in lead refining.⁵

Patents⁶ were issued to H. M. Burkey (American Metal Co.) for treating mixtures of oxide of arsenic and antimony. Sodium carbonate or alkali compound is fused with the oxides to produce the metallic antimony and sodium arsenate. When molten lead is added to the bath antimonial lead is formed. Another patent⁷ relates to the purification of antimony by passing chlorine gas into the molten metal. The various chlorides evolved are separated from each other and used in other products. A process for producing antimony salt from stibnite has been patented. The finely ground ore, digested with calculated quantities of sodium sulphide and sulphur in hot water, forms a solution of sodium thioantimonate, which is diluted and then sprayed into an atmosphere of sulphur dioxide. The resulting mixture of antimony pentasulphide and sulphur, after being separated from the sodium thiosulphate solution that forms at the same time, may be used directly for vulcanizing rubber. By treating the thiosulphate solution with antimony trichloride "antimony crimson" is obtained and sulphur dioxide is regenerated.

Antimony may be separated rapidly and efficiently from lead by the Harris process, in which antimonial lead is melted and trickled through molten caustic soda. From sodium antimonate thus formed the metal or its compounds can be readily produced.

⁵ Bureau of Mines, Properties of Antimony Oxides: Press Release, Mar. 26, 1929.

⁶ Production of Metallic Antimony, Alloys of Antimony, and Alkali Arsenates: United States Patents 1654527 and 1654528, Jan. 3, 1928; Chem. and Ind. (London), vol. 47, Mar. 30, 1928, p. 235.

⁷ Rose, C. A., and Read, C. L., Purifying Antimony: United States Patent 1662439, Mar. 13, 1928; Chem. Abs., vol. 22, Apr. 20, 1928, p. 1322.

TARIFF HISTORY

Antimony ore has been imported free of duty since 1870, except under the act of 1909 when its antimony content was dutiable at 1 cent a pound.

Antimony regulus or metal paid an import duty of 10 per cent ad valorem for 26 years, beginning in 1864. The act of 1890 changed the ad valorem rate to a specific duty of three-fourths of a cent a pound—a reduction. In the act of 1894, antimony was on the free list; but the act of 1897 restored the specific duty of three-fourths of a cent a pound, as in the tariff of 1890. In the 1909 act the duty was doubled. After 23 years under specific rates (except for three years on the free list) antimony metal was again made dutiable on an ad valorem basis in 1913, being returned to the early rate of 10 per cent. Except in 1916, when the average price was 25.1 cents a pound, the 10 per cent rate was operated as a reduction in the duty in comparison with the 1½-cent specific rate of the act of 1909.

Paragraph 8 of the act of 1922 provides the following duties on antimony compounds: "Oxide, 2 cents per pound; tartar emetic or potassium antimony tartrate, 6 cents per pound; sulphides and other antimony salts and compounds not specially provided for, 1 cent per pound and 25 per centum ad valorem."

Paragraph 376 of the same act provides as follows: "Antimony, as regulus or metal, 2 cents per pound; needle or liquated antimony, one-fourth of 1 cent per pound."

In the tariff hearings before the Ways and Means Committee in January, 1929, H. P. Henderson requested increases in the duties both on regulus and oxide—from 2 cents per pound to 4 cents per pound—in order primarily to encourage the establishment of a smelter at Laredo or at some other point in the State of Texas for the treatment of Mexican ores. It was claimed that substantial production in this country would tend to stabilize prices.

WORLD SOURCES

*World production of antimony, 1920–1928, in metric tons*¹

[Compiled by L. M. Jones, of the Bureau of Mines]

Country ²	1920	1921	1922	1923	1924	1925	1926	1927	1928
North America:									
Mexico.....	623	45	464	490	775	1,398	2,614	1,924	3,578
United States.....			4	8	24	24	31		30
South America:									
Argentina.....	³ 50		⁴ 1	⁴ 5	³ 120	⁴ 10	³ 158	(⁵)	
Bolivia ⁴	484	282	185	312	621	1,384	3,503	3,214	2,834
Peru.....	⁴ 7					8	47	53	68
Europe:									
Austria.....			139	62	1		87	857	914
Czechoslovakia.....	330	384	100	453	1,066	535	938	1,586	967
France.....	1,130	1,276	834	691	1,027	964	586	658	893
Germany (Bavaria).....		2	4	(⁵)	(⁵)	(⁵)			
Greece.....	46								
Hungary.....	93								
Italy.....	187	76	146	271	372	312	360	285	230
Portugal.....				8	14	15			(⁵)
Spain.....				25			14	10	7
Yugoslavia.....	(⁵)	(⁵)	(⁵)	131	414	139	182	279	258

¹ Approximate recoverable metal content of ore produced, exclusive of antimonial lead ores.

² In addition to the countries listed, antimony ore is reported produced in Siam and Chosen, as follows: Siam, 9 tons of ore in 1924; Chosen, 21 tons of ore in 1926 and 15 tons in 1927. As no information is available on the antimony content of these ores, the figures have not been included in the table.

³ Railway shipments. A large part of the shipments reported is probably of Bolivian origin and therefore may duplicate in part the quantities shown for Bolivia.

⁴ Exports.

⁵ Data not available.

World production of antimony, 1920-1928, in metric tons—Continued

Country	1920	1921	1922	1923	1924	1925	1926	1927	1928
Asia:									
China ⁴	13,001	14,658	13,858	14,256	12,059	19,496	20,028	17,211	18,361
India, British.....	(⁵)	1	-----	-----	-----	5	53	244	(⁵)
Japan.....	-----	-----	-----	-----	10	-----	-----	-----	(⁵)
Turkey (Asia Minor) ⁷	400	400	400	400	400	400	400	400	400
Africa:									
Algeria ⁴	1,000	103	579	500	905	1,461	334	442	21
Morocco, Spanish ⁴	-----	-----	-----	-----	-----	-----	70	94	225
Nigeria ⁴	(⁸)	(⁸)	(⁸)	(⁸)	-----	-----	-----	-----	-----
Southern Rhodesia.....	2	-----	-----	-----	-----	15	24	-----	40
Oceania:									
Australia—									
New South Wales.....	81	50	-----	-----	-----	12	34	51	48
Queensland.....	-----	-----	-----	-----	-----	-----	3	2	1
Victoria.....	406	141	605	421	130	54	-----	-----	1
Western Australia ⁴	(⁹)	-----	-----	-----	-----	-----	(²)	-----	-----

⁴ Exports.⁵ Data not available.⁶ Estimated recovery from ore produced, 2 kilograms.⁷ Estimated.⁸ Less than 1 ton. The estimated recoverable metal content of ores exported was as follows: 1920, 178 kilograms; 1921, 74 kilograms; 1922, 190 kilograms; 1923, figures not given.⁹ Less than 1 ton. Estimated recoverable metal content of ores exported was as follows: 1920, 278 kilograms; 1926, 464 kilograms.**BOLIVIA**

Numerous antimony deposits have been found in Bolivia, extending all the way from the Argentine border to Peru. Most of them, however, are in the southern area in and near the tin mines. Stibnite is the principal mineral, and it occurs in fine-grained, compact masses, often accompanied by pyrite and sometimes by wolframite or gold. Antimony ocher is formed by weathering. The gangue is usually quartz and occasionally dolomite or siderite but never barite or fluorspar. According to Voge,⁸ the antimony content is raised to 60 per cent and even 68 per cent by hand cleaning. The chief impurities are lead, iron, and arsenic, but these may all be kept down to less than 0.5 per cent each. Some of the mines are "open-pit" but most of them are operated through shafts. Mining methods are primitive, and the ore is taken out on contract, mostly by hand picks. Mechanical concentration is employed at some mines; most of the material, however, is hand sorted by Indian women, and the waste may run as high as 20 per cent antimony. The mines are situated mostly at elevations of 13,000 feet or more and at some distance from the railroad. Llamas carry ore a distance of approximately 10 miles a day. At one mine, in order to save on transportation an attempt was made to treat the ore in a reverberatory furnace that used wood as fuel; a 75 per cent product was made, but the results were not satisfactory, owing to the faulty construction of the furnace. Other attempts have been made to smelt antimony in Bolivia, but these attempts likewise have proved failures, partly because of the cost of fuel in most of the districts and partly because of lack of experience. Moreover, most of the deposits are too small individually to support a smelter. At present, therefore, all the ore is exported to North America and Europe. Great Britain usually takes 60 to 80 per cent of the exports, fairly large shipments are made to France, Belgium, and the United States,

⁸ Voge, Law, Antimony in Bolivia: Eng. and Min. Jour.-Press, Apr. 24, 1926, pp. 677-679.

and smaller quantities are destined for Germany and Argentina. According to United States Consul J. C. McGurk the principal exporters are Duncan, Fox Co., La Paz; W. R. Grace & Co., La Paz; and Hochschild & Co., Oruro. Although sulphide and oxide ore are not reported separately in the statistics the quantity of oxides exported is known to be insignificant.

Before the World War the production of antimony in Bolivia was unimportant, but as the price rose various mines were opened, and at one time as many as 180 were operating. The most important mines are those in the district of Yura (south of Agua Castilla, along the railroad to Potosi), in Huarojla (near Cotagaita), in Sucre and Candelaria (near Esmoraca), and in the Province of Chayanta.

After the war the production declined almost to the zero point. Beginning in 1924 there was a revival induced by the increase in prices which reached a maximum of 25 cents a pound in January, 1926. Since the working costs in Bolivia are high (ranging, according to local conditions, from \$28 to \$56 a ton f. o. b. mine), only a few mines can be worked under present prices.⁹ The most important producer is the San Juan mine, near Tupiza.

Export taxes are collected on antimony ore. These are on a sliding scale, based on the price of ore in London. When that price is under 6s. a unit the tax is 44 centavos (about 14 cents United States currency) a metric quintal of actual antimony content.

CANADA

Antimony ore occurs in Nova Scotia, New Brunswick, British Columbia, Ontario, Quebec, and the Yukon Territory. Shipments were made as early as 1886, but they have been irregular and generally small. It is claimed that there are large deposits in New Brunswick at Lake George, about 24 miles north of Fredericton, where mining has been conducted in a more or less desultory fashion for 20 years or more. Late in 1927 interest in these deposits was renewed by reports that production on a substantial scale would be made soon. New capital was obtained, and plans were made for a large chemical manufacturing plant that would utilize the ore. There are said to be two veins on the property, which range in width from 6 inches to 3 feet (averaging 20 inches), and which have been exposed by 10 shafts over a length of more than a mile. Water transportation is available in summer up the St. John River to within 3 miles of the mine, which is also near the railroad. The ore ranges from 30 to 58 per cent antimony and contains a little gold and silver. Early in 1928, 100 men were reported at work, and one or two trial shipments had been made.

The Lake George deposits were discovered in 1863, and the property has been worked off and on during the past 60 years by various companies. At one time a small smelting plant was erected, which produced about 1 ton of metal a week. Attempts were made to concentrate the ore by hand sorting, the lumps being shipped to Swansea, but these efforts failed because of the disseminated nature of the ore.

⁹ Ahlfeld, F., *Los Minerales de Antimonio en Bolivia*: Revista Minera de Bolivia, vol. 2, June, 1927, pp. 171-177.

Gravity concentration in jigs and vanners was tried, but losses in slime were excessive. A decrepitation process found successful in France on other ores of antimony was installed by another company, but the New Brunswick ore failed to decrepitate, and the plant was abandoned. Arsenical pyrite occurs in the wall rock and may become mixed with the ore in mining, causing difficulties in the refining process. A Montreal firm undertook to remove the arsenic by leaching the mixed oxides of arsenic and antimony obtained by sublimation, but this did not prove an economic success.¹⁰

There are rumors that the smelter at Trail, British Columbia, will undertake the recovery of antimony before long.

CHINA

In 1928 China shipped 8,470 short tons of regulus, 1,562 tons of oxide, and 577 tons of crude antimony to the United States, compared with 7,875 tons, 684 tons, and 924 tons, respectively, in 1927. Prior to the World War Chinese antimony was shipped mostly to Europe, whence American purchases were transshipped to the United States. The business is now done direct. Last year the United States obtained almost three-fourths of its imports of regulus from China and accounted for substantially more than one-half of the total exports from that country. England, France, the Netherlands, Germany, and Japan, approximately in the order named, accounted for most of the remainder of the exports from China.

Antimony is widely distributed throughout China, but the principal deposits are in the Provinces of Hunan, Yunnan, Kweichow, Kwangtung, Szechwan, and Kwangsi. By far the greater part of the output, however, comes from Hunan and chiefly from the Sikwanshan mines. Visible reserves have been reliably estimated at 2,000,000 tons, and further development would undoubtedly result in opening up even larger supplies. The antimony is in seams, pockets, and masses in quartzite. The grade of the ore is usually around 30 per cent, although 60 per cent material is often encountered. According to United States Consul H. L. Milbourne there are reported to be 420 antimony mine owners in the Sikwanshan area and about 22 elsewhere in Hunan. The number of smelters is placed at 35. Smelting formerly was conducted largely at Changsha, but it is now done mainly at the mines. These smelters use primitive native methods, since it has been demonstrated that these with coolie labor are cheaper than modern mechanical practice. In 1928 labor was cheap and plentiful, and, despite a falling off in demand, production continued at a moderately high rate throughout the year. As a result stocks accumulated, amounting at the end of the year to approximately 4,900 tons, equivalent to about three months' production. Of this amount 900 tons was stored at the Sikwanshan mines, 1,900 tons at Changsha, 1,700 tons at Hankow, and 400 tons at other mines. These figures do not include unknown quantities that were in transit both between the mines and Changsha and between Changsha and Hankow; such quantities may have been considerable, as it takes 16

¹⁰ Parsons, C. S., *The Lake George Antimony Ores and Their Concentration*: Canadian Min. Jour., vol. 49, May 18, 1928, pp. 405-408.

days to 2 weeks for the ore to go from the mines to Changsha. From Changsha most of the shipments are made to Hankow, where the antimony either goes into warehouses or is transshipped at once. During the annual rise in the water level of the Yangtze River Hankow becomes a port for ocean-going steamers, and direct shipments to America and Europe are possible, but during low water all shipments must go by river steamers from Hankow to Shanghai before they can be exported. Even in periods of high water shipments are often made in this way. Between Changsha and Hankow river boats, which are owned by British, Japanese, or Chinese firms, usually charge \$4 (Mexican currency) a ton for transport during periods of high water and \$6 (Mexican currency) a ton during low water which lasts ordinarily from October or November to March or April; from Hankow to Shanghai the rate is \$7 (Mexican currency). It is always necessary to make a transfer at Hankow as there are no through boats from Changsha to Shanghai. Ocean rates from Shanghai to New York have in recent years been about \$10 (United States currency) a ton and from Hankow \$12. There is usually an additional charge of 50 cents for transfer from river steamers to ocean vessels.

Certain foreign firms deal directly with the miners, but most of the business is transacted through native brokers. Owing to the great number of mine owners production can be increased quickly whenever prices begin to rise. Conversely, when there is a decline the high-cost mines are closed. Under these circumstances the supply of antimony would seem to be remarkably flexible and should tend quickly to adjust itself to demand. It happens, however, that despite this situation the price is subject to wide swings. In addition to the vagaries of the world market local speculation is an important factor. Many Chinese invest in antimony instead of putting money into the bank, and since the total monthly output seldom exceeds 1,500 tons it takes only \$200,000 or \$300,000 to corner the market.

Attempts are frequently made to form syndicates. Although none of these attempts has yet been successful, at least for any considerable period, they almost always produce a temporary effect on prices. In 1928 there were several spurts of speculation, notably the advances in late April and early October, because of rumors of a sales monopoly being formed, and throughout the year prices at Changsha and Hankow were consistently higher than in foreign markets. In July the price was \$280 (Mexican currency) a long ton, ex-warehouse, Changsha, and \$332, ex-warehouse, Hankow. These figures are near the border line of costs as usually estimated for many of the Chinese mines. By September, however, the price at Changsha had jumped to \$318, and at Hankow it reached \$370. If \$300 (Mexican currency) is the cost limit, Chinese production may be expected to drop off rapidly whenever the price in New York falls below 7½ cents a pound.

Most of the exports from China consist of regulus; better grades contain 99 per cent of the metal, and are reasonably free from deleterious impurities. A small amount of oxide is made directly from ore, but the bulk of the Chinese oxide production, which is relatively small, is a by-product of regulus smelting.

FRANCE

France has long been a rather important factor in the antimony industry. Nearly all the mines and works are in the Departments of Mayenne, the Haute-Loire, the Cantal, and La Vendée. As the mines in the Haute-Loire region produce principally low-grade ore they have not been operated extensively of late. In 1927 the production in France was 940 metric tons of regulus, 285 tons of antimony sulphide, and 1,615 tons of oxide. Of this output 328 tons of regulus, 34 tons of sulphide, and about 2 tons of ore were exported. Imports, however, were much larger than exports; they comprised 420 metric tons of regulus, 290 tons of sulphide, and 2,460 tons of ore.¹¹ In 1928 imports of ore dropped to 1,840 metric tons, and domestic production of ore increased to 4,132 metric tons. France apparently requires about 3,000 tons of antimony (or 7,500 tons of ore) to meet her normal peace-time requirements. Before the World War France frequently produced 1,000 or 2,000 tons of metal in a year more than she needed. During that war imports exceeded exports by 100 or 200 tons annually. Even during the Riffian War French imports increased substantially. Recently there has been an annual deficit of 1,000 to 1,800 tons. Although adequate supplies could be obtained from domestic mines it does not appear to be economical to do so. The French ore is of low grade, yielding usually only about 25 per cent of metal.

Algeria.—Antimony ore is also obtainable in substantial amounts in Algeria, but deposits there likewise seem to be of low grade. Exports of ore from Algeria in 1928 were only 56 metric tons, as compared with 1,255 tons in 1927.

Indo-China.—Comparatively rich ore was opened up in French Indo-China, which in 1917 furnished more than 2,000 tons, but which has reported no production since.

GERMANY

According to various newspaper reports¹² the Deutsche Bodenschätze Gesellschaft, Düsseldorf, has acquired the exclusive right to exploit antimony ore deposits that have been discovered on the Wolfersgrün Common in Upper Franconia and that official investigations are said to have shown to be of great value. An analysis of the ore shows 28.4 per cent of antimony. Exploitation is to begin at once. These deposits, it is expected, not only will satisfy Germany's own requirements but may provide a surplus for export.

During the last year or more electrolytically refined antimony has been produced in commercial quantities in Germany by the Norddeutsche Affinerie, which has offered notched ingots of about 60 pounds each having a minimum purity of 99.7 per cent antimony. A patent¹³ issued to this company mentions the use of hydrofluoric acid and sulphuric acid in the electrolyte.

¹¹ Mining Journal (London), The French Antimony Industry: Vol. 162, Sept. 1, 1928, p. 742.

¹² Mining Journal (London), Antimony Discovery in Germany: Vol. 163, Dec. 15, 1928, p. 1049.

¹³ Antimony: German Patent 294143, July 18, 1927; Chem. Age, vol. 19, No. 484, Oct. 6, 1928, p. 31.

MEXICO

The production of antimony in Mexico almost doubled in 1928—amounting to 3,578 metric tons, compared with 1,924 tons in 1927 and 2,614 tons in 1926. Prices, however, were much lower, the average in 1928 being 49 cents (Mexican currency) a kilogram (about 22 cents a pound), compared with 82 cents in 1927.¹⁴

The only antimony smelter in Mexico is at Wadley, San Luis Potosi, on the main line of the National Railway of Mexico; the ore comes from the Sierra de Catorce district, only a short distance away. By-product antimony in the form of antimonial lead is produced in varying quantities by the lead smelters (chiefly at Peñoles and Monterey). A fairly substantial and increasing tonnage of ore, chiefly antimony ocher (stibiconite), containing about 50 per cent of antimony, is produced in the Altar district of Sonora and is shipped by motor truck or wagon to Santa Ana and thence by rail to the United States. Mining in Oaxaca has resulted in sporadic exports to England, and in 1928 there was some prospecting in the State of Queretaro; mines in both of these States are owned by the Cookson interests.

There are many deposits of antimony in Mexico, especially in Sonora. With respect to production, Mexico rivals Bolivia as the second largest source of world supply, but antimony mining in Mexico has been handicapped by the lack of a market for the ore. In 1881 a smelter at Oakland, Calif., treated antimony ore from Sonora, but the enterprise does not appear to have been successful; the smelter itself was soon destroyed by fire. After a lapse of several decades antimony mining was resumed in Sonora in 1915 and was continued until after the World War. Then another break came, from 1920 to 1924, but in 1925 Sonora produced ore containing 170.5 short tons of metallic antimony. In 1926 the output was equivalent to 902 tons and in 1927 to 695 tons.¹⁵ Recently ore has been shipped from Sonora to the Eagle-Picher Lead Co. in Missouri. In 1927, 50 per cent ore brought \$1 a unit of antimony content, f. o. b. cars, Santa Ana, Sonora. The ore was mined and delivered to the railroad by Mexican contractors. Labor at the mines is plentiful and wages are about the same as they are elsewhere near the border. Common labor receives 2.50 to 3 pesos and miners receive 3 to 3.50 pesos for an 8-hour shift.¹⁶

The Cookson enterprise in San Luis Potosi has been described in considerable detail by Charles Bruchold,¹⁷ from whose article the following information is abstracted:

The antimony-smelting plant at Wadley is owned by an English company, the Republic Mining & Metal Co. (Ltd.), a subsidiary of Cookson & Co. (Ltd.), the principal office of which is at Milburn House, in Newcastle-on-Tyne, England. For 30 years this firm has engaged solely in the business of mining antimony, having various mineral concessions of the metal in different States of the Republic. At the present time, it is working only the mines of Catorce, State of San Luis Potosi. At the beginning of this century when the company

¹⁴ Boletín Minero (monthly), Mexico City, Mexico.

¹⁵ Altaffer, M. W. (American consul, Nogales, Sonora, Mexico): Cons. Rept. 277841, Apr. 13, 1928, p. 3.

¹⁶ Altaffer, M. W.: Work cited, p. 5.

¹⁷ Boletín Minero, El Antimonio en Mexico y su Beneficio en Wadley: Vol. 26, No. 4, October, 1928, pp. 259-267.

was working the mines near Wadley, all the mineral extracted was sent to England to be refined there. But in the year 1904 the smelter at Wadley was installed. At the beginning of the revolution, this smelter was forced to operate irregularly, but during the World War it increased its production considerably, treating about 6,000 tons of ore yearly, with an average yield of 17 to 32 per cent antimony. Since then the furnaces have been operated with more or less regularity, according to the world-market price. The increase in consumption (which we shall call normal) that began in 1925 was taken advantage of for the enlargement of activities at Wadley.

The smelter is located near Wadley station on the railroad that leads to Laredo, Tex., and is served by a spur track, which facilitates the loading of products and the unloading of coke and crude petroleum for the furnaces. The ore comes to the plant from the United Catorce mines, which are about 11 kilometers east of Wadley, and which are owned by the same company. Haulage is by motor trucks over a good road. The ore consists mainly of oxides derived from the alteration of stibnite and includes cervantite ($\text{Sb}_2\text{O}_3 \cdot \text{Sb}_2\text{O}_2$), yellow in color; stibiconite ($\text{Sb}_2\text{O}_3 \cdot \text{H}_2\text{O}$), yellowish to reddish white in color; and valentinite (Sb_2O_3), white in color. A little sulphide ore is picked out by hand and used in the reverberatories to mix with the crude metal obtained by smelting the oxidized ore in blast furnaces. The ore charged in the blast furnaces averages 34.7 per cent Sb, 1 per cent Fe, 31 per cent insoluble, and 14 per cent CaO . Because the ore consists of oxides, the simple smelting method used in China can not be employed, and the more complicated method of precipitating the metal with iron, which is used in England, likewise is said to be unsatisfactory. Blast-furnace smelting of antimony oxide, having previously proved successful in Hungary, was finally adopted at Wadley. The furnaces are jacket furnaces, rectangular in section, measuring 1.52 by 0.92 meters at the tuyere level. The height from the tap hole to the charging floor is 6.55 meters. The ore is mixed with 17 per cent of iron oxide, which comes from Cerro de Mercado, Durango, and 10 per cent of limestone, which is quarried near by. About 25 per cent of coke is used; this fuel comes from Coahuila. The manipulation of the furnaces is similar to that of a lead furnace.

The antimony metal and slag are tapped into a movable forehearth, or settler, where they are separated. Slag containing as much as 1 per cent antimony is wheeled to the dump in iron pots. The metal, which is impure—containing 5 to 7 per cent iron, 1 to 2 per cent sulphur, and a little slag—is carried molten to the refinery yard, where it is poured out on the ground, to be later broken up with sledge hammers.

A considerable amount of fume is made in the blast furnace; this passes to a bag house. The flue dust is briquetted and returned to the furnaces.

The blast-furnace metal, locally called "singles," is refined in reverberatory furnaces into a purer product known as "doubles," which in turn is subjected to a final refining, or "starring," process. In the first reverberatory a little stibnite, which, as previously stated, is hand picked, is added to separate the iron and copper. From 3 to 7 per cent of carbonate of soda or potash also is added in order to slag off the sulphur and arsenic. The average daily capacity of the plant is 6 tons of star antimony, 99.7 per cent pure. There are two blast furnaces, each capable of handling about 20 tons of crude ore, averaging 34.7 per cent antimony daily, but these furnaces are run alternately. The reverberatory furnace can handle 15 tons in 24 hours, but it is run intermittently. The yield of regulus is approximately 1 ton for each 3.45 tons of ore treated. The cost of smelting and refining is about \$80 a ton of ingot. Of this about one half is attributed to refining and the other half to other expenses, including overhead. The plant employs 80 wage earners and 9 officials, including the superintendent.

The metal is exported principally to the United States, although shipments are made to Europe also. In addition to the regulus a small amount of antimony oxides is produced and sold locally as paint after being ground and mixed with linseed oil and with other pigments.

The antimony deposits near Wadley have been described very fully by Edmundo Villafaña,¹⁸ Mexican mine inspector.

¹⁸ Boletín Minero, Las Minas de Antimonio Ubicadas cerca de Wadley, S. L. P.: Vol. 26, No. 4, October, 1928, pp. 227-233.

RUSSIA IN ASIA

An expedition was sent into southern Ferghana in 1927 to study antimony and mercury deposits.¹⁹

SOUTH AFRICA

Antimony is found in several places in South Africa, where it is often associated with gold. An experimental plant has been built recently at Hatherly to treat the antimony ore found in the gold reefs of the Murchison Range, in the Transvaal. The deposits, which lie within a belt approximately 30 miles long, have been worked spasmodically at various times. At Hatherly the ore averages $12\frac{1}{2}$ per cent of antimony and about 8 pennyweights of gold. The table concentrates contain 40 per cent of antimony; they are first roasted to oxide and then reduced to metal.²⁰

¹⁹ Shtcherbakov, D. I., and Sosedko, A. F., Work of the 1927 Expedition to Southern Ferghana for Study of the Antimony and Mercury Deposits: Russia Acad. Sci. C. R. No. 11, Leningrad, 1928, pp. 181-186.

²⁰ South African Mining and Engineering Journal, A Murchison Range Revival: Vol. 39, pt. 1, Apr. 28, 1928, pp. 213-214.

RARE METALS

By FRANK L. HESS¹

COBALT

GENERAL CONDITIONS

In 1928, as in a number of preceding years, the United States produced no cobalt and consumption was represented more or less closely by imports. During the last 10 years imports have been as follows:

Cobalt ore, cobalt, and oxide imported for consumption in the United States, 1919-1928

Year	Ore		Cobalt		Oxide		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919.....	17, 045	\$2, 832	60, 511	\$141, 450	131, 424	\$184, 751	208, 980	\$329, 033
1920.....	13, 039	4, 794	143, 603	326, 864	202, 724	399, 605	¹ 359, 586	¹ 731, 277
1921.....	7, 657	3, 235	38, 442	105, 539	164, 003	342, 426	210, 102	451, 200
1922.....	5, 195	7, 075	126, 364	321, 396	217, 530	435, 895	² 349, 089	² 764, 366
1923.....	58, 719	56, 326	225, 639	552, 434	258, 574	511, 903	² 542, 932	² 1, 120, 663
1924.....	28, 786	37, 276	118, 952	264, 935	226, 703	440, 898	² 374, 441	² 743, 109
1925.....	34, 782	31, 320	198, 669	422, 185	287, 265	546, 292	² 520, 716	² 999, 797
1926.....	154, 468	55, 820	387, 076	820, 873	333, 132	632, 478	¹ 874, 786	¹ 2, 509, 211
1927.....	60, 382	3, 019	407, 193	841, 442	369, 747	703, 608	² 837, 327	² 1, 548, 069
1928.....	107, 498	25, 922	535, 817	1, 147, 574	364, 154	692, 753	² 1, 007, 469	² 1, 866, 249

¹ Includes 220 pounds of zaffer, valued at \$14, in 1920, and 110 pounds, valued at \$40, in 1926. No zaffer imported 1919, 1921 to 1925, 1927, and 1928.

² Also 11 pounds of "other salts and compounds," valued at \$26, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to change in tariff. Similar additional imports in 1923 were 45,644 pounds, valued at \$27,356; in 1924, 797 pounds, \$856; in 1925, 13,256 pounds, \$7,894; in 1926, 37,342 pounds, \$21,647; in 1927, 55,127 pounds, \$28,681; and in 1928, 68,281 pounds, \$39,993.

Cobalt compounds imported for consumption in the United States, 1926-1928¹

	1926		1927		1928	
	Pounds	Value	Pounds	Value	Pounds	Value
Linoleate.....	2, 522	\$952	55, 045	\$28, 617	68, 150	\$39, 791
Sulphate.....	34, 466	20, 163	82	64	131	202
Other salts.....	354	532				
	37, 342	21, 647	55, 127	28, 681	68, 281	39, 993

¹ Figures on imports and exports compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

Cobalt and cobalt ore imported into the United States, 1926-1928, by countries

[General imports]

Country	1926		1927		1928	
	Pounds	Value	Pounds	Value	Pounds	Value
Africa, British West.....					6, 832	\$200
Australia.....					88, 200	13, 822
Belgium.....	259, 738	\$597, 496	205, 211	\$455, 799	260, 900	611, 566
Canada.....	274, 347	264, 441	223, 291	312, 774	217, 586	404, 370
Chile.....					6, 164	3, 897
Germany.....	7, 454	14, 731	39, 078	75, 888	63, 633	139, 611
	541, 539	876, 668	467, 580	844, 461	643, 315	1, 173, 496

During 1928 the Belgian, Canadian, and British operators continued their close control of the supply and price of cobalt. The Belgian supply is obtained from veins carrying cobalt, copper, and iron sulphides near Elisabethville, Katanga, Belgian Congo. The Canadian supply is derived from cobalt arsenides and arsenosulphides accompanying silver in the veins of the Cobalt district, Ontario. Part of the British supply is mined from cobalt arsenosulphide veins in the Cloncurry district of Queensland; the remainder is saved as a by-product from nickel ores that are mined near Sudbury, Ontario, and treated by the Mond process at Clydach, Wales.

The price was held throughout 1928 at \$2.10 for the black oxide and about \$2.50 to \$3 per pound for the metal, f. o. b. Deloro, Ontario. The London quotations were 8s. for black oxide, 8s. 10d. for gray oxide, and 10s. per pound for metal, equivalent to \$1.95, \$2.15, and \$2.43, respectively.

Like bismuth, cobalt is found in small quantities at many places and in large quantities at very few places.

The chief use of cobalt is in the making of stellite, the corrosion-resistant group of alloys made of cobalt and chromium to which tungsten and other metals are added to adapt the properties to particular needs. Magnet steel, tool steels, and corrosion-resistant steels take other quantities of metallic cobalt. The new tungsten carbide tools are also using some cobalt. Organic cobalt salts are used for driers in paint, and some cobalt is used as pigment in pottery and enamels.

WORLD PRODUCTION

The production of cobalt is given from the several producing countries in such indefinite figures that the estimates are not very exact, but from various official reports the following data have been compiled.

World production of cobalt, 1926-1928, in metric tons

Country	Cobalt-bearing material	1926		1927		1928	
		Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content
Australia: Queensland..	Cobaltite concentrates, etc..	137.2	27.4	-----	-----	40	8
Belgian Congo.....	Copper-iron-cobalt alloy.....	794	1360	2,100	2558	(3)	1450
Canada: Ontario.....	Cobalt, alloys, and chemicals	794	302	(3)	399	(3)	434
Chile.....	Arsenosulphide ore.....	6.4	(3)	3	(3)	(3)	(3)
China: Yunnan.....	(3)	2250	(3)	2250	(3)	2250	(3)
Germany: Saxony.....	Cobalt-bismuth-nickel ores..	155	27.4	92	(3)	(3)	(3)
New Caledonia.....	Concentrates ¹	-----	-----	578.6	23.5	(3)	(3)
		-----	(3)	-----	(3)	-----	(3)

¹ Cobalt in metal, oxide, and salts produced at Oolen, Belgium.

² Estimated.

³ Data not available.

⁴ Cobalt-bearing manganese oxide.

⁵ Exports.

BIBLIOGRAPHY

Of the literature on cobalt, appearing or becoming available during 1928, which has come to the attention of the United States Bureau of Mines, the following articles seem worthy of notice.

BRACE, PORTER H. (to Westinghouse Electric & Manufacturing Co.). Permanent-magnet steel. U. S. Patent 1678001, July 24, 1928. Chem. Abs., vol. 22, September 20, 1928, p. 3388.

"A magnet steel comprises cobalt (1-10 per cent) and chromium or other metal of the chromium group (1-10 per cent), the remainder being mainly iron and minor impurities."

CARPENTER, H. C. H. Alloy steels—their manufacture, properties, and uses. Chem. News, vol. 136, May 18, 1928, pp. 307-310.

"Cobalt magnet steel discovered by Honda and Takagi in 1917 contains essentially from 30 to 40 per cent of cobalt with from 0.4 to 0.8 per cent of carbon in the steel. In their patent specification, however, they extend the cobalt range to from 20 to 60 per cent. They also give from 3 to 9 per cent of tungsten and from 1.5 to 3 per cent of chromium. The most suitable heat treatment for this steel is an oil quenching from 950° to 1,000° C., when it is endowed with a coercive force of from 220 to 250, together with a remanence of the order of 10,000. On account of the high coercive force, however, magnetization is difficult, and it is necessary to use very high magnetizing fields (1,400 c. g. units) in order to obtain saturation and the high figures of remanence and coercive force quoted. Since the discovery of cobalt magnet steels, many patents on steels containing varying amounts of cobalt with additions of other elements have been taken out. Among them may be mentioned those of Hadfield in this country [England], Krupp in Germany, and Sumitomo Chukosho in Japan. These cover a very wide range of composition and properties. According to Kayser steels of the composition chromium 9 to 15 per cent, cobalt 1 to 18 per cent, and carbon above 1 per cent are air hardening. The compositions quoted have been arrived at empirically by experiment. The explanation of their action must await proper scientific investigation."

CERNATESCO, R., and VASCAUTANU, MRS. E. Determination of cobalt as cobalto-cobaltic oxide in a stream of oxygen. Ann. Sci. Univ. Jassy, vol. 15, 1928, pp. 69-70. Chem. Abs., vol. 22, July 10, 1928, p. 2337.

"In an oxidizing atmosphere the most stable oxide is Co₃O₄, provided the temperature is not too high. Calcination of black cobalt hydroxide (from the precipitation of Co(NO₃)₂·6H₂O with KOH and Br) over a good Bunsen flame in a slow current of O₂ gave results differing from +0.14 to -0.32 per cent from theoretical."

DYSON, G. MALCOLM. The extraction and utilization of cobalt. Chem. Age, vol. 19, 1928, pp. 33-35, 41-42.

FRASER, F. Mold for pressed sheet glass. U. S. Patent 1670110, May 15, 1928.

Chem. Abs., vol. 22, July 10, 1928, p. 2449.

"Molds are formed of a 'noncorrosive' metal alloy such as nichrome, Monel metal, or stellite. Various structural features are specified."

GREGORY, J. W. The nickel-cobalt ore of Talnotry, Kirkcudbrightshire. Inst. Min. and Met. Bull. 277, 1927, pp. 1-5.

HERMANN, OTTO. Thermocouple. U. S. Patent 1637822, August 2, 1927.

The negative element is formed of an alloy of nickel, cobalt, and molybdenum, and the positive element may be formed of a nickel-copper or nickel-copper-cobalt alloy.

HOWARTH, W. E. On the occurrence of linnaeite in the coal measures of South Wales. Geol. Mag., vol. 65, 1928, pp. 517-518.

KROLL, FRANZ. The Katanga copper belt. Abstract translation from Metall u. Erz. Min. Jour. (London), vol. 161, 1928, p. 559.

"The greatest known cobalt ore occurrences of the world are those of Canada and Katanga, the latter being in the Union Minière copper concession. The cobalt ores, occurring as they do in association with the copper ores, are naturally found under the same geological conditions. The association of the copper and cobalt ores is often so intimate that they can not be separated in the ore-dressing works.

"Cobalt has always been regarded as a by-product of the copper recovery by the Union Minière and treated accordingly. It occurs chiefly in the Etoile, Ruashi, and Luisha mines. In the last mine it is found partly as a black sandy material and as a friable black ore.

"In depth the cobalt mineral has been identified as linnaeite, $\text{CoS} \cdot \text{Co}_2\text{S}_3$. Other Luisha ore has a content of about 9 per cent of copper and 9 per cent of cobalt. The cobaltic ore of the Etoile mine and at Ruashi has been identified by Professor Schoep, of Geneva University, as containing heterogenite (a hydrated oxide of cobalt containing copper). It is intimately mixed with malachite and chrysocolla.

"The cobalt ores are divided into two classes—those which contain less than 6 per cent Co and must be concentrated and those containing over 6 per cent of Co which can be smelted directly for cobalt.

"The separation of copper and cobalt oxides is effected rather easily in the metallurgical way. By employing weak reduction conditions in the water-jacket furnace, by lowering the coke in the charge and increasing the air supply to the furnace, practically only the copper becomes reduced, while the cobalt passes into the slag. In this way it is possible to obtain a black copper of 98 to 99 per cent, with not more than 0.7 per cent of cobalt, while, on the other hand, a slag with 6.5 per cent Co, 5 per cent Cu, and 9 to 11 per cent Fe is obtained. This slag, together with rich cobalt ore, is reduced in an electric furnace. This furnace is of 400 kw. capacity, with upper and lower electrodes. The flux is lime; nearly complete reduction of the copper and cobalt and about 7.5 per cent of the iron results. From 4 to 5 per cent of coke is used for reduction. The cast alloy divides into two layers, of which the part consisting of iron and much cobalt is easily dissolved in sulphuric acid. The alloy is shipped to Belgium for further treatment in the Oolen works. By dissolving the alloy in acid the copper remains undissolved as a metal scum on the solution. The pulverizing of the alloy would be difficult and expensive were it not for the fact that at 900° it is brittle enough to be broken into small pieces of 2 to 5 cm. in a stonebreaker. The separation is made by precipitating the iron as hydroxide, by simultaneous oxidation by means of air, and filtration in a filter press. The pure cobalt sulphate is converted to oxide by well-known methods, and the oxide is reduced to pure metal. The production of the cobalt plant at Oolen in 1926 amounted to about 300 tons, reckoned as pure cobalt metal."

LITTLE, JAMES MACFARLANE. The geology and metal deposits of Chile.

II. Ore deposits, general: Metals found in Chile, 1926, p. 17.

Metals found in quantities too small to be of much economic importance and which are seldom mined are cobalt, nickel, vanadium, antimony, and bismuth.

MELLERSH-JACKSON, L. Improving the mechanical properties of heavy metals (nickel, cobalt, and lead) or their alloys. From Siemens & Halske A. G. British Patent 295971, May 21, 1927. Chem. and Ind. (London), vol. 47, October 25, 1928, p. 789.

"The tensile strength and hardness of nickel, cobalt, lead, or nickel-copper alloys with more than 10 per cent nickel are considerably increased by the addition of 0.1 to 15 per cent of beryllium, together with small quantities of magnesium, tin, zinc, antimony, aluminum, cadmium, carbon, or silicon. The worked alloys are annealed at 600°-900°, quenched, and aged at 150°-600°. A suitable nickel alloy contains 92.5 per cent nickel, 2 per cent beryllium, 5 per cent silicon, and 0.5 per cent carbon. Addition of 0.2 per cent beryllium increases the strength of lead by 100 per cent without heat treatment."

METAL INDUSTRY (LONDON). Nickel, nickel alloys, and cobalt. Vol. 33, 1928, pp. 607-610.

Describes the Wiggin Street works laboratories, the electrical research laboratories and, besides nickel alloys, other special alloys. Very little is said about cobalt.

MINING MAGAZINE (LONDON). Gold and cobalt discovery. Vol. 39, 1928, p. 299.

"In connection with the discovery of highly mineralized ore in the mine of the Edwards (Waaikraal) Goldfields, in the Rustenburg district, Transvaal, it is officially announced that the final assays from the Consolidated Gold Fields laboratory, Johannesburg, give the following results: Per ton of 2,000 pounds 52 ounces 13 pennyweight of gold, 9.6 pennyweight of silver, 3.95 per cent of cobalt, 10.89 per cent of arsenic. Presuming all the cobalt and arsenic to be present in the form of smaltite, this would give 14 per cent cobalt arsenide. A further sample submitted to Messrs. Littlejohn and Whitby gave the following assay per 2,000 pounds: 53 ounces 6 pennyweight of gold and 5.3 per cent of cobalt. A third sample sent to Barclays Bank in Johannesburg, to be assayed for cobalt only, resulted as follows per 2,000 pounds: 9.7 per cent of cobalt."

QUEENSLAND GOVERNMENT MINING JOURNAL. Other minerals. Vol. 29, 1928, p. 147.

"On the Cloncurry field, only two men were employed throughout the year at Mount Cobalt in cobalt mining, while at the Queen Sally cobalt mine the only work done was of a prospecting nature."

RIERA, J. F. Synthetic aquamarines. British Patent 271316, October 4, 1926. Chem. Abs., vol. 22, May 10, 1928, p. 1660.

"Synthetic aquamarines are prepared by fusion of a mixture comprising silica, beryllia, and alumina, colored with a medium of which cobalt nitrate is the basis; the fusion product may be broken up and reheated to form molded pieces of desired size. A flux may be used formed of Li_2CO_3 or LiOH , fused H_3BO_3 and sodium borate."

SCHLECHT, LEO, and KEUNECKE, EMIL (to I. G. Farbenindustrie, A. G.). Nickel and cobalt carbonyls. Canadian Patent 283414, September 18, 1928. Chem. Abs., vol. 22, November 10, 1928, p. 4212.

"Cobalt and nickel carbonyls are produced by roasting cobalt speiss with air and steam and treating with H at 400°, then leaching the product with $(\text{NH}_4)_2\text{CO}_3$ solution saturated with gaseous NH_3 , expelling the NH_3 by heating, and precipitating the metals in the form of their hydroxides and basic carbonates by dilution, thereupon reducing the product with dry H at 350°, and treating the metal thus obtained with CO at 150° under a pressure of 200 atmospheres."

SOUTH AFRICAN MINING AND ENGINEERING JOURNAL. The outlook for Waaikraal. Vol. 39, 1928, p. 164.

A borehole "was stopped at 66 ft. in magnetite."

"Cobalt is found in appreciable quantities associated with the magnetite which bulks largely on the property. Two and a half tons of the highly mineralized gold and cobalt ore recovered have been stored preparatory to being shipped to England for treatment, report, and realization. Recent assays of the cobalt ore give values up to 1 per cent metal, and the profitable possibilities of this mineral are obviously considerable. The main shaft, it should be mentioned, is down about 160 feet on the incline, and work has been done along the strike for a distance of 450 feet."

The mine was described by Dr. Percy A. Wagner before the Geological Society of South Africa on August 30, 1926, the location of the mine being given as in the Rustenburg district, roughly 25 miles northeast of Rustenburg and about 42 miles west-northwest of Pretoria.

MOLYBDENUM

DOMESTIC PRODUCTION

During 1928 a total of 328,989 short tons of ore was milled in the United States, from which 3,415 tons of concentrates carrying 1,714 short tons of molybdenum were made. The molybdenum mineral was all molybdenite (MoS_2). Three companies produced molybdenum ore in 1928—the Climax Molybdenum Co., at Climax, Colo.; the Molybdenum Corporation of America, at Sulphur Gulch, between Questa and Red River, N. Mex.; and the Santo Niño Mining Co., at Helvetia, Ariz. The Leviathan Molybdenum Co. did development work at the Leviathan mine, in the Hualpai Mountains, 50 miles southeast of Yucca, Ariz.

Data on the production of molybdenum in the United States during the last 10 years are given in the following table.

Molybdenum in ore and concentrates, produced in the United States, sold in 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	297,926	\$341,814	1924.....	297,174	(1)
1920.....	34,900	17,207	1925.....	1,154,050	² \$961,324
1921.....			1926.....	(3)	(3)
1922.....			1927.....	2,286,075	1,858,786
1923.....	22,667	(1)	1928.....	3,329,214	1,924,600

¹ Value not reported.

² Estimate by Bureau of Mines.

³ Bureau of Mines not at liberty to publish figures.

Calcium molybdate was quoted throughout 1928 at 95 cents to \$1 per pound of contained Mo.

IMPORTS

The imports since 1919 are shown in the following table.

'Molybdenum ore' ¹ (steel-hardening)' imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	106,743	\$77,572	1924 ²	10,379	\$9,038
1920.....	15,639	9,707	1925 ²	1,954	1,793
1921.....	29,783	20,471	1926 ²	13,397	11,175
1922.....	412,221	90,015	1927 ²	12,541	10,472
1923 ²	16,671	13,115	1928.....		

¹ 1919-1922, recorded as molybdenum ore; 1923-1928, recorded as molybdenum content of ore.

² Classification under tariff of Sept. 22, 1922, "Molybdenum ore and concentrates (molybdenum content)."

WORLD PRODUCTION

The accompanying table shows the world production of molybdenum in 1927 and such data as are obtainable for 1928. The table has been compiled from available official reports.

World production of molybdenum ores and concentrates, 1927 and 1928

Country ¹	Mineral	Ore	Concen- trates	Per cent MoS ₂	Con- tained molyb- denum	Value
1927		<i>Metric tons</i>	<i>Metric tons</i>		<i>Metric tons</i>	
Australia: Queensland.....	Molybdenite.....	(2)	1	(2)	(2)	\$997
Austria.....	Wulfenite.....	(2)	(3)	-----	(3)	(2)
Chile.....	Molybdenite.....	(2)	1.5	95	0.8	965
Chosen.....	do.....	(2)	30	(2)	(2)	14,512
Italy.....	do.....	3	(2)	10	.2	309
Norway.....	do.....	(2)	155	80	74.4	132,843
Russia ⁴	do.....	(2)	3.8	86	(2)	(2)
United States.....	do.....	196,491	2,064	84.22	1,043	1,869,700
1928						
Australia: New South Wales.....	do.....	(2)	2	(2)	(2)	1,898
Austria.....	Wulfenite.....	(2)	(2)	(2)	3.3	(2)
Chile.....	Molybdenite.....	(2)	(2)	(2)	(2)	(2)
Chosen.....	do.....	(2)	31	(2)	(2)	17,873
Morocco, French.....	do.....	(2)	1	(2)	(2)	745
Norway.....	do.....	(2)	(2)	(2)	(2)	(2)
Russia ⁴	do.....	(2)	(2)	(2)	(2)	(2)
United States.....	do.....	298,452	3,098	83.66	1,555	1,981,700

¹ In addition to the countries listed, Mexico is a producer of molybdenite, but data of output are not available for the years under discussion.

² Data not available.

³ Quantity less than one-quarter of a ton (50 kilograms). Content of molybdenum 33.3 kilograms.

⁴ Year ended Sept. 30.

⁵ Exports.

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The following articles on molybdenum, to which is appended a list of recent patents, are among those appearing in 1927 and 1928.

BINNIE, D. Measurement of high temperatures by means of a tungsten-molybdenum thermocouple. Jour. Roy. Tech. Coll. Met. Club, Glasgow, vol. 6, 1927-28, pp. 35-36, 42. Chem. and Ind. (London), vol. 47, December 21, 1928, p. 915.

"A tungsten-molybdenum thermocouple may be used for temperature measurements up to 2,000°, provided that oxidation is avoided by passing a current of hydrogen through the furnace or through the protecting tube of the couple. The thermoelectric curve is almost a parabola with the equation $y = 0.151x^{2.125}$, the neutral temperature occurs at 618° when the E. M. F. of the junction is 1.36 millivolts and the reversal point at 1,218° using a cold junction at 18°. Above the reversal point tungsten is the electropositive metal. The tungsten wire should not exceed 0.4 mm. in diameter nor the molybdenum wire 0.64 mm."

DOERNER, H. A. Notes on the determination of molybdenum. Inf. Circ. 6079, Bureau of Mines, 1928, 2 pp. Chem. Abs., vol. 22, November 10, 1928, p. 4081.

"The method, which is discussed in U. S. Bureau of Mines Bulletin 212, depends upon dissolving the sample in aqua regia, evaporating with H₂SO₄, removing PbSO₄, and adding NH₄OH and 3 grams of Na₂CO₃ to the filtrate therefrom. This serves to precipitate calcium and other interfering ions. After thorough digestion the precipitate of carbonates and hydroxides is removed, tartaric acid and H₂S are added, and any precipitate that forms is removed. The alkali sulphide solution is then made acid and MoS₃ filtered off. The MoS₃ is dissolved in aqua regia and a PbMoO₄ precipitate is formed in a properly buffered solution and weighed."

DÖHMER, P. W. (Molybdenum resistance furnace.) Ztschr. Ver. deut. Ing., vol. 72, 1928, p. 556. Chem. Abs., vol. 22, July 20, 1928, p. 2515.

"A molybdenum wire winding is used in this tube furnace, protected from oxidation by methyl alcohol vapor. Temperatures of 1,500° and more are maintained for several hours without oxidation of the winding."

DYSON, G. MALCOLM. The extraction and utilization of molybdenum. Chem. Age, vol. 18, 1928, pp. 33-34.

Molybdenum may be added to steel in several ways—as one of the silicides Mo₂Si₃ and Mo₂Si, where silicon is to be added as well as molybdenum, or in the

form of various alloys with other metals. Thus, two "patent" alloys for addition to steel for the production of a clean, malleable, but tough product were found to have the following analyses (No. I is recommended for large forgings, 1.5 per cent being added, while No. II is added in quantities up to 3 per cent for the production of steel for shell cases):

	Per cent			Per cent	
	I	II		I	II
Molybdenum.....	70.53	36.25	Carbon.....	2.94	1.08
Nickel.....	21.6	57.8	Silicon.....	.42	.14
Tungsten.....	1.27		Sulphur.....	Traces.	Traces.
Iron.....	3.08	1.6	Manganese.....	.40	Traces.

There is little doubt that the bulk of molybdenum is utilized in the manufacture of high-speed tool steel containing 5 to 10 per cent of molybdenum. Molybdenum steel is intensely tough, far less liable to crack, and capable of standing extremely heavy torques. Its use is indicated in the case of propeller shafts. In addition, it retains its temper at a dull red heat. The increase of strength in forged molybdenum steel increases with the molybdenum content up to a certain point.

FERSMAN, A. G. U. S. S. R. resources in mineral raw materials; their geographical distribution and exploitation in chemical industry. First All-Russian Conference on Problems of Chemical Industry. Jour. Chem. Ind. (Moscow), vol. 4, 1927, pp. 277-282.

HULL, ALBERT W., and HYATT, J. M. Secondary electron emission from molybdenum. General Electric Co. Phys. Rev., vol. 29, 1927, p. 214. Chem. Abs., vol. 22, November 10, 1928, p. 4053.

"A special 3-electrode tube was used, consisting of a short straight tungsten filament in the axis of a long cylindrical molybdenum grid and plate. The tube was thoroughly exhausted, a small quantity of cesium introduced, the tube sealed off from the pump, and the plate bombarded with cesium positive ions at 600 volts for 5 hours. The tube was then immersed in liquid air and the plate heated by induction until the plate current showed no change with continued heating. Measurements of plate current were made, as a function of grid and plate voltage from 0 to 2,000 volts. The fraction of the primary electrons which reached the plate was determined by removing the tube from liquid air, reversing the potentials, and measuring the positive-ion currents from the filament K grid and plate. The number of secondary electrons per primary electron was thus calculated and found to increase from 0.45 at 20 volts to a maximum of 1.23 at 900 volts, decreasing to 1.04 at 2,000 volts. These values were reproducible at different times and in different tubes to 2 per cent."

MILLER, HENRY J., and LINDEMAN, MARCELLA. Behavior of molybdenum as a resistor in the electric furnace. Am. Inst. Min. and Met. Eng., Tech. Publication 16. Class E., Inst. of Metals No. 3, 1927.

"The destruction of molybdenum ribbons used as resistors in electric furnaces is due chiefly to chemical reaction with materials present. Of those materials most likely to be there, silica and carbon are the most destructive. For the best working conditions of such furnaces it is recommended that:

"1. Both heating tubing and insulation should be of calcined pure alumina, mixed with aluminum hydroxide as binder, and fired at 1,500° C.

"2. The first heating of a new furnace should be carried out under high hydrogen pressure, which may be later reduced.

"3. If the material used for heating tubing or insulation contains carbon, oxides of a high degree of oxidation should be added, so that they may react with it, the products of the reaction to be removed by evacuation.

"4. The molybdenum ribbon may be coated with molybdenum oxides having a low degree of oxidation to protect it from forming oxides or carbides."

MINING JOURNAL (LONDON). Molybdenum as a material for electric furnace resistances. Vol. 163, 1928, p. 872.

"In electric furnaces with platinum resistances it is possible to reach a temperature of 1,300° without having to protect the platinum against oxidation. Beyond that temperature the platinum begins to vaporize, the result being rapid wear of the resistances. Since the manufacture of molybdenum wire became

practicable, attempts have been made, in view of the high-melting point of the metal, to employ molybdenum wire for the manufacture of resistances, but for this purpose it is necessary to prevent the oxidation which takes place as soon as the metal is carried to the incandescent stage. The *Journal du Four Electrique* has a note on a furnace evolved by a German firm, in which, in order to obviate oxidation, methyl alcohol vapor is used. The molybdenum wire is coiled around a tube of gas-proof material, the whole being then inclosed in a tube, which is also gas proof. The space between the two tubes is filled with methyl alcohol vapor, the latter being contained in a receptacle, from which it runs in drops. With such a furnace it is possible to reach a permanent temperature of $1,450^{\circ}$, and, for a short time only, up to $1,500^{\circ}$. Even higher temperatures would be practicable if it were not for the lack so far of ceramic material capable of resisting temperatures above $1,500^{\circ}$, while remaining gas proof at such temperatures. A period of $1\frac{1}{2}$ to 2 hours is required for the furnace to reach the maximum temperature. The methyl alcohol reservoir must be replenished about every two hours. As molybdenum has a very high positive temperature coefficient, it is possible to employ automatic heat regulators as in the case of platinum resistance furnaces."

— The mineral resources of Tanganyika. Vol. 161, 1928, p. 342.

Refers to the occurrence of molybdenum in the Usaga Mountains.

PAYNTER, C. R. Molybdenite mining in Victoria. *Chem. Eng. and Min. Rev.*, vol. 21, 1928, pp. 47-48.

"At the present time Australia is not producing any molybdenite, due to the low prices ruling and the demand being readily satisfied by the United States. New South Wales ceased production in 1916 with a yield of 54 tons; Queensland ceased just after the war with a yield of 110 tons in the year; while Victorian production ceased early in 1927.

"Victorian molybdenite deposits occur in the northeast of the State of Everton, between Wangaratta and Beechworth, the field being cut by the railway between these two towns. The field is about 3 miles long and a quarter of a mile wide, the mineral occurring in granite bosses.

"For some time the deposit was mined, the rock being broken and hand picked. Rock containing less than 1 per cent molybdenite was sent to the waste dump, while the richer ore was trucked to Melbourne for treatment.

"At the end of 1919 the Standard Molybdenite Mining Co. erected on the lease a plant capable of treating 50 tons of ore per week. This company continued until early in 1927, when, owing to the unremunerative price, it was forced to close, and no production has resulted from the area since then.

"The floated material contained about 60 per cent of molybdenite, and in order to increase this percentage the concentrate was given a further flotation in a 1-compartment 6-inch stirrer subaeration M. S. and de B. machine fitted with a propeller for agitation. The floated material was then hand skimmed and transferred to steam-heated drying vats. It was then hand bagged into white calico bags which, for safety against bursting, were placed in Hessian bags. Each bag averaged about 90 pounds, while the material was graded as 86 per cent. The price for this grade to-day is in the vicinity of £161 5s. per ton, rising to £169 17s. per ton.

"The company had an output of 15 to 25 hundredweight of 86 per cent molybdenite per week, which was transported by rail to Melbourne for shipment abroad."

QUEENSLAND GOVERNMENT MINING JOURNAL. Other minerals. Vol. 29, 1928, p. 146.

"A little activity was displayed in mining for rare metals at Wolfram. The Queensland Rare Metals Mines obtained a crushing of 250 tons from the face of the Forget-Me-Not tunnel in the Larkin lease, and also from the stopes below the tunnel. The return was 5 tons of bismuth-wolfram concentrate and one-half ton of molybdenite. Operations were then suspended. A crushing of 25 tons from the Avoca mine gave a return of 15 hundredweight of bismuth wolfram concentrate and one-half ton of molybdenite."

SVENSSON, CARL. Leaching of molybdenite ores. *Am. Electrochem. Soc. Trans.*, vol. 51, 1927, pp. 377-384.

The Landfall mine, near the town of Drammen in south Norway, is on a steep vein of complex molybdenite-bearing rock, 3 to 6 feet thick, inclosed in granite. It is exposed at the surface for about 300 feet and has been worked to a depth of only 2 feet. The percentage of molybdenum in the rock ranges from 0.5 to 4 per cent or more. The molybdenite is in very fine flakes, rather uniformly distributed through the rock. Through hand sorting the molybdenum

content of the ore can easily be made from 1.5 to 2 per cent MoS_2 . A sample of 500 pounds of rejected rock contained 1.14 per cent of Mo. Though hard, the ore is not difficult to crush and grind, after roasting, which is necessary for leaching purposes. The ore was ground to about 70 mesh.

With hydrochloric acid, 80 to 90 per cent of the molybdenum in the ore could be volatilized at about 650°C . By leaching the residue with a very dilute hydrochloric acid solution 5 to 10 per cent more was extracted, so that almost all of the molybdenum could be recovered. Results with chlorine were not so satisfactory, and molybdenum was not effectively volatilized by chloridizing roasting, but was easily dissolved by subsequent leaching with dilute hydrochloric acid. Acid extraction seems out of the question because of the quantity of alumina and lime dissolved. Efforts to volatilize the molybdenum as oxide were unsuccessful. Leaching with ammonia was also unsuccessful. Soda solution was found to give good results. The molybdenum was precipitated from soda solution either as calcium molybdate or molybdenum sulphide. Estimates of the amount of chemicals required are given. Methods have not yet been tried on an industrial scale. The MoO_3 produced by the calcium molybdate method is estimated to cost 20 cents a pound. Sulphide precipitation may be somewhat lower.

PATENTS

ALLGEMEINE ELEKTRICITÄTS-GES. Coating oxide cathodes of thermionic valves. British Patent 268815, April 1, 1926. Chem. Abs., vol. 22, April 20, 1928, p. 1256.

"Filaments of tantalum oxide or other oxide are coated with metal—e. g., molybdenum—by applying a paste of the finely divided metal admixed with a viscous material such as paraffin or a sugar solution which does not react with the oxide at normal temperature, and then heating to the liquefaction temperature of the metal. A further coating of electron-emitting material may be applied."

BAGLEY, GLEN D. Electric vacuum furnace. U. S. Patent 1671461, May 29, 1928.

A vacuum furnace is made with a mercury seal and a tungsten or molybdenum resistor.

COBB, B. G. Treating ores of zinc, molybdenum or other metals having volatile oxides. U. S. Patent 1660150, February 21, 1928. Chem. Abs., vol. 22, April 20, 1928, p. 1319.

"A molten bath is formed from flux and old siliceous slag with an oxidizing atmosphere above the bath. Molybdenite or other ore is introduced into the zone above the bath (in an apparatus which is described) and the bath is maintained at a sufficiently high temperature to effect volatilization and oxidation of desired substances such as molybdenum, zinc, lead, arsenic, or antimony."

HAY, J. T. Corrosion-resistant ferrous alloy. British Patent 290487, September 5, 1927. Chem. and Ind. (London), vol. 47, July 20, 1928, p. 527.

"The alloy contains 0.2 to 0.5 per cent copper, up to 0.2 per cent carbon and molybdenum (preferably less than 0.1 per cent of each), and other inclusions less than 0.25 per cent."

LUCAS, E. A. Manufacture of molybdenum alloying compounds. U. S. Patents 1681123 and 1681124, August 14, 1928. Chem. and Ind. (London), vol. 47, October 26, 1928, p. 790.

"A composition for use in preparing molybdenum alloys comprises a fused mass of molybdenum trioxide and lower oxides with a basic oxide as a flux. Molybdenite is roasted to expel sulphur, and the product is fused with a reducing agent, a flux, and lime to form a coherent fused mass containing a calcium-molybdenum silicate."

MARDEN, J. W., assignor to Westinghouse Lamp Co. Preparation of electron-emission material (thorium-molybdenum alloy). U. S. Patent 1670463, May 22, 1928. Chem. and Ind. (London), vol. 47, August 17, 1928, p. 612.

"A mixture of molybdenum powder and the compound Th_3Al_4 is formed into bars, which are sintered in a high-frequency induction furnace in vacuo until the aluminum is volatilized and the thorium is thoroughly incorporated with the molybdenum. The alloy is then swaged, forged, and drawn or rolled as required. Alternatively, a molybdenum plate or anode is coated with Th_3Al_4 and heated in an evacuated valve, whereby the thorium becomes incorporated with the molybdenum and the aluminum acts as a getter in the valve."

METALLWERK PLANSEE G. m. b. H. An improved process for the production of molybdc and tungstic acid. British Patent 269947, March 8, 1928.

SARBEE, MAURICE D. Electric vacuum furnace. U. S. Patent 1671451, May 29, 1928.

Molybdenum or tungsten used as resistor for electric furnace.

TANTALUM

DOMESTIC PRODUCTION

As in other recent years, the only columbite reported as produced in the United States in 1928 was from the Black Hills of South Dakota, where it was mined by the Black Hills Tin Co., at Tinton, by Collingwood & Greene, near Pringle, and by A. T. Roos, near Rapid City. The quantity shipped in 1928 amounted to 34,899 pounds, valued at \$26,332. The Black Hills Tin Co. milled ore from the dike that it was developing for tin mining. So far as is known to the Bureau of Mines, this is the first tantalum ore milled and concentrated in this country, all previous production having been hand-picked material. The ore at Tinton has been crushed and recemented by albite, so that it is not well adapted to hand picking. Most of the ore sold in 1928 was exported to Liverpool, England, and to Germany; that going to Liverpool was for the manufacture of ferro-tantalum columbium, but the use of that going to Germany is unknown. The material shipped carried 75 per cent or more of the combined pentoxides of tantalum and columbium, of which 45 per cent or more was Ta_2O_5 .

The following table shows the production of tantalum minerals in the United States (all from South Dakota) during the past 10 years.

Columbite, mined in the United States, shipped in 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	300	\$90	1924.....	1, 197	\$598
1920.....	4, 000	1, 450	1925.....	-----	-----
1921.....	3, 400	1, 150	1926.....	2, 100	650
1922.....	600	240	1927.....	1, 100	378
1923.....	1, 350	540	1928.....	34, 899	26, 332

USES

During 1928 J. Bishop & Co., Malvern, Pa., placed on the market tantalum laboratory apparatus made from metal reduced by the Fansteel Products Co., of North Chicago, Ill. Crucibles, evaporating and digesting dishes, spatulas, cathodes for electrolytic copper determinations, and other articles were advertised. The cathodes are used with platinum anodes. Tantalum is also used for making spinnerets for artificial silk, and it is claimed that holes less than two ten-thousandths of an inch in diameter can be made through them. The tantalum for such use is made from minerals imported from Western Australia—tantanalite, manganotantalite, and others—in which the tantalum content is very much higher and the columbium content is correspondingly lower than in the minerals produced in the United States. The cost and difficulty of isolating the tantalum in these Australian minerals are therefore much less than in minerals such as those produced in the United States.

Dr. C. W. Balke continued experimental work on columbium, but the metal has not yet been placed on the market.

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The following articles are among those on tantalum that appeared or became available during 1928.

CHEMICAL ENGINEERING AND MINING REVIEW. Tantalite in Australia. Vol. 20, 1928, p. 384.

"The Pilbara field, Western Australia, is the principal producing center of tantalite in Australia. Messrs. Young and Moulden, of Adelaide, work leases at Wodgina and also purchase any small lots raised. The production in 1926 was 19.45 tons, valued at £2,357. In 1927 the output fell to 15.28 tons, but the value was higher, viz, £3,808. The output is regulated by the demand. The firm mentioned is under contract to sell the whole output to an American concern. Tantalite also occurs in association with tin in the same district and at Greenbushes, but the separation is a difficult matter. It has also been reported from Coolgardie.

"In the Northern Territory Messrs. James Gitsham and A. J. Johnson are developing a find of tantalite on the Finnis River, about 65 miles from Port Darwin. They have a contract for the supply of 20 tons to the Fansteel Co. of New York [North Chicago]. Inquiries are reaching Australia from Great Britain, America, and Europe, and the price offered has increased from 30s. per unit for 60 per cent ore to 80s. Some buyers offer to accept concentrates containing as low as 45 per cent Ta_2O_5 ."

INDUSTRIAL AUSTRALIAN AND MINING STANDARD. Tantalite mining in Western Australia. Vol. 80, 1928, p. 303.

"Since June last there has been increased activity in the mining of the mineral tantalite in Western Australia. Prior to 1923 the total value of this product mined in the State was £18,092. Last year the yield was worth £3,746, and in 1926, £5,751. For the months of May, June, July of this year about $7\frac{1}{4}$ tons were obtained at a value of £1,814. The tantalite mines at Wodgina are being worked by a company in which Lady Hacket Moulden, of Adelaide, and formerly of Western Australia, is chiefly interested. Whilst in America recently Lady Moulden was able to arrange a contract for several years ahead with certain interests in the United States."

KIEHL, S. J., and HART, DAVID. The reduction of columbic acid. Jour. Am. Chem. Soc., vol. 50, 1928, pp. 1608-1620.

M-O VALVE CO. (Ltd.) and STOPFORD, C. W. Thermionic valves. British Patent 277754, June 25, 1926. Chem. Abs., vol. 22, July 20, 1928, p. 2498.

"The filament is secured to its supports by a solder consisting of a mixture in powdered form, of C, a metal such as molybdenum, tungsten, or tantalum having a higher melting point than the normal temperature of the joint, and a metal such as copper having a lower melting point. Various structural details also are specified."

SAW, W. W. Tantalum and niobium. Chem. Eng. and Min. Rev., vol. 19, 1927, pp. 468-469.

A general article covering the occurrence of Ta and Cb in Western Australia. It also gives the properties of the minerals and their constituents.

SCRIVENOR, J. B. The geology of Malayan ore deposits. London, 1928, 216 pp. Briefly describes tantalum deposits in the Malayan Peninsula.

THUT, HENRIQUE G. (Rare-metal deposits in Brazil.) Chim. Ind., vol. 1, 1926, pp. 349-354; vol. 2, 1927, pp. 383-384, 403-404.

WELLS, R. C. Note on the J. Lawrence Smith method for the analysis of samarskite. Jour. Am. Chem. Soc., vol. 50, April, 1928, pp. 1017-1022.

TITANIUM

DOMESTIC PRODUCTION

During 1928, as in preceding years, the principal interest in titanium was in its use in pigments. As rutile is comparatively rare, only ilmenite has been used for this purpose, and the production of titanium has been mostly in that form.

Rutile was produced in 1928 at the plant of the American Rutile Co. at Roseland, Nelson County, Va., with about an equal quantity of ilmenite. Ilmenite and rutile were also shipped from the Buckman & Pritchard (Inc.) operation 4 miles south of Jacksonville Beach, Fla. A little ilmenite was produced in Los Angeles County, Calif., by the Minerals Conversion Co., of Los Angeles.

There were only two shippers each of ilmenite and rutile in the United States in 1928, and the Bureau of Mines is not at liberty to publish the figures. The production of titanium minerals during the last 10 years, so far as data are available to the bureau for publication, is shown in the following table; the quantities are largely for shipments rather than direct production.

Titanium minerals produced in the United States, 1919-1928

Year	Rutile concentrates			Ilmenite concentrates		
	Short tons	Percentage of TiO ₂	Value	Short tons	Percentage of TiO ₂	Value
1919 ¹	102	94-96	\$20,400	106	48-50	\$2,120
1920.....	277	94-96	(²)	268	50	(²)
1921.....						
1922.....	310	95	(²)	5,181	52-54	(²)
1923.....	270	95	(²)	6,270	52	(²)
1924.....				4,769	52	³ 76,300
1925.....	46	95	³ 11,000	5,566	52	³ 89,000
1926 ⁴	30	95	³ 7,500	4,813	52	³ 77,000
1927.....	(²)	(²)	(²)	3,500	50	44,000
1928.....	(²)	(²)	(²)	(²)	(²)	(²)

¹ Virginia production only; information regarding Florida not available for publication.

² Bureau of Mines not at liberty to publish figures.

³ Arbitrary value.

⁴ Figures for Florida only. Bureau of Mines not at liberty to publish figures for Virginia.

IMPORTS

During 1928 a considerable quantity of ilmenite was imported into the United States—13,305 short tons from India, valued at \$48,050 (\$3.61 per ton); 2,240 tons from Senegal, valued at \$25,500 (\$11.38 per ton); and 1,679 tons from the Netherlands, valued at \$6,090 (\$3.63 per ton); a total of 17,224 short tons, valued at \$79,640. Imports of ilmenite for earlier years are not separately recorded by the Bureau of Foreign and Domestic Commerce. Indian ilmenite comes from Travancore and is said to carry 53 per cent or more of TiO₂; the high percentage is due to tiny particles of rutile intergrown with the ilmenite. No figures are at hand to show whether ilmenitic ores were imported from Canada during 1928, but ilmenite carrying 15 to 18 per cent of TiO₂ has been shipped at times to the United States from Ivry and St. Urbain, Canada, for the manufacture of ferrotitanium. The St. Urbain deposit carries some rutile.

GENERAL CONDITIONS

C. O. Terwilliger, the National Lead Co., and the Vanadium Corporation of America did some drilling and other prospecting in Nelson County, Va., but the only production known to have been made was that of the American Rutile Co.

All three of the new operations are reported to be on nelsonite, a dike rock composed typically of rutile and apatite, although in some dikes other rock-forming minerals, such as feldspar and quartz, are also found.

If operations actually begin a quantity of apatite about equal in quantity to the ilmenite and of comparatively high purity will be produced. There is at present no known market for this phosphate, but it seems probable that some use may be found for it. Apatite is said to be less soluble in sulphuric acid and therefore more difficult to make into commercial fertilizers than the phosphates of the sedimentary rocks; when produced in a comparatively pure crushed form, however, it may form a profitable by-product.

Many bauxites carry considerable titanium dioxide, and Indian bauxite is reported to carry as much as 11 per cent of TiO_2 . At the East St. Louis plant of the Aluminum Ore Co., a subsidiary of the Aluminum Co. of America, the waste sludge daily discharged from the treatment of bauxite contains more than 75,000 pounds of TiO_2 . The results of experiments (see reference in bibliography on page 119) carried out by W. H. Coghill, of the U. S. Bureau of Mines, on deslimed sands carrying 24.33 per cent of TiO_2 encourage further work on gravity separation of the titanium dioxide.

The market for titanium minerals is very limited; sales are all at prices which are more or less a matter of bargaining. Ilmenite containing 50 per cent of TiO_2 was quoted by the Engineering and Mining Journal at \$9.50 to \$11 per long ton. Rutile in carload lots was quoted at 9½ cents per pound. The best artificial titanium dioxide was quoted at the beginning of 1928 at 44 cents per pound in 300-pound barrels and on June 1 at 35 cents.

WORLD PRODUCTION

The world production of titanium minerals in 1927 and 1928, as gathered from Government reports and other available sources, is shown in the following table.

World production of titanium minerals, 1927 and 1928, in metric tons

Mineral and country	1927			1928		
	Ore produced	Content of TiO_2	Value ¹	Ore produced	Content of TiO_2	Value ¹
Ilmenite:	<i>Metric tons</i>	<i>Per cent</i>		<i>Metric tons</i>	<i>Per cent</i>	
Brazil ²	1,307	³ 53	\$25,737			
Canada (Quebec).....	1,841	³ 35	8,977	2,036	(⁴)	\$6,726
India (Travancore).....	18,095	³ 54	162,567	(⁴)	(⁴)	(⁴)
Norway.....	5,733	43.6	44,802	(⁴)	(⁴)	(⁴)
Portugal.....	703	(⁴)	3,181	(⁴)	(⁴)	(⁴)
Senegal.....	5,200	³ 50	16,323	2,110	³ 50	6,623
United States.....	3,175	50	44,000	(⁴)	(⁴)	(⁴)
Rutile:						
Norway.....	45	90-93	14,066	(⁴)	(⁴)	(⁴)
United States.....	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)

¹ Values as officially reported, converted to United States currency at the annual average rate of exchange as published by the Federal Reserve Board.

² Exports.

³ Estimated.

⁴ Data not available.

⁵ Bureau of Mines not at liberty to publish figures.

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The following articles and patents concerning titanium have recently appeared.

BARTON, L. E., and RYAN, L. W., assignors to Titanium Pigment Co. (Inc.). Manufacture of composite titanium pigment. U. S. Patent 1680316, August 14, 1928.

BOOGE, JAMES E. Recent improvements in the quality of American lithopone. Paint, Oil, and Chem. Rev., vol. 86, 1928, pp. 18b-c. Chem. Abs., vol. 22, November 10, 1928, p. 4260.

"Lithopone production is now over 175,000 tons a year and has passed both white lead and zinc oxide. Recent improvements in texture and ease of mixing are reviewed. Texture is defined as freedom from coarse material, grit, hard aggregates, etc. Three tests for hiding power in general use are outlined, viz, indirect tinting strength, cryptometer, and paint-out test. The latter is preferred and a method given. Relative hiding powers so determined with lithopone as 100 are as follows: American process ZnO 85-90, titanox 120-135, 50 per cent ZnS lithopone 135-140; ZnS and TiO₂ run between 200 and 300. Methods for testing texture and ease of mixing are given."

BRÄKKEN, H. The crystal structure of titanium monoxide. Ztschr. Kryst. Mineral., vol. 67, 1928, pp. 547-549. Chem. Abs., vol. 22, November 10, 1928, p. 4020.

"TiO has a sodium chloride type of structure, with $a = 4.235$ Å. U. The calculated density is 5.536. The data seem to indicate that the compound is not ironized."

BROWN, BRUCE K. Large-scale titanium pigment production based on old laboratory process. Chem. and Met. Eng., vol. 35, 1928, pp. 427-428.

Describes operations of Commercial Pigments Corporation, at Curtis Bay, Baltimore.

CANADIAN MINING JOURNAL. Canadian titanium in 1927. Vol. 49, 1928, p. 788.

COFHINA, J. Gravimetric determination of titanium in iron alloys. Separation (of titanium). Ztschr. anal. Chem., vol. 73, 1928, pp. 40-46. Chem. and Ind. (London), vol. 47, April 27, 1928, p. 301.

"The alloy (0.5-10 g.) is dissolved in aqua regia and the solution evaporated with 5-20 c. c. of sulphuric acid (d 1.8) until copious fumes are evolved. The solution is cooled, diluted with 100 c. c. of cold water, neutralized with sodium carbonate, treated with 2 c. c. of sulphuric acid (1:1) and 6 grams of sodium thiosulphate, and poured slowly into 400 c. c. of boiling water. After boiling for 1 to 2 minutes the liquid is cooled, filter pulp added, and the precipitate collected, washed with hot water, and ignited to titania. The use of an excess of thiosulphate is stated to prevent precipitation of part of the titania."

COGHILL, W. H. Titanium in bauxite ores and sludges. Repts. of Investigations, Serial 2867, Bureau of Mines, 1928, 4 pp. Chem. Abs., vol. 22, July 10, 1928, p. 2341.

"Specific gravity (float and sink) fractionation of granular bauxite sludge indicates that titanium oxide distribution is not favorable to making a rich concentrate by gravity methods. Table concentration was tried. When the titanium was in a mixture of clay and bauxite, very little selection was shown, indicating its presence in minerals such as leucoxene and xanthitane. Leucoxene is a whitish, granular, flocculent mineral indistinguishable from the mass of amorphous Al(OH)₃, and xanthitane (a hydrous titanate of Al) is a yellow, friable, earthy substance. A general distribution of titanium found in bauxite seems to accord with the well-known statistical information that the lithosphere has a tenor of 0.77 per cent TiO₂. Much of it is too disseminated for concentration."

D'ANS, JEAN and SOMMER, FRITZ. Titanium oxide. U. S. Patent 1655940, January 10, 1928. Chem. Abs., vol. 22, March 20, 1928, p. 1019.

"A titanium ore containing iron is reacted on with concentrated H₂SO₄ in about double the quantity of the ore and the reaction mixture is treated with H₂O about equal in quantity to the ore treated; the solution obtained is subjected to the action of a reducing agent such as iron or to electrolytic reduction to reduce Fe₂(SO₄)₃ to FeSO₄ and the latter is removed from the solution by crystallization. The mother liquor is then heated to above 150° in an autoclave under pressure to precipitate titanium oxide."

DITMAR, R. Titanium dioxide rubber enamels. *Chem. Ztg.*, vol. 52, 1928, pp. 506-507. *Chem. and Ind. (London)*, vol. 47, August 17, 1928, p. 614.

"Fine-grained titanium dioxide is very suitable for the production of snow-white and highly luminous, colored rubber enamels, since it has a better white-coloring power than, for example, zinc oxide, improves the rubber material, and, unlike coloring agents containing zinc, is nonpoisonous. Such enamels may be produced from vulcanized rubber, since the latter is rendered very plastic and adhesive by the titanium oxide. By the use of sulphur monochloride vapor the enamels may be vulcanized in 6 minutes instead of the usual 34-44, giving well-aged and more durable products."

EVENSON, O. L., and McCUTCHEM, D. T. Use of buffers in the determination of color by means of titanium trichloride. *Ind. and Eng. Chem.*, vol. 20, 1928, p. 861.

"The color content of Amaranth may be determined by titration with titanium trichloride in the presence of sodium citrate, sodium bicarbonate, or potassium antimony tartrate. That of Ponceau 3R may be determined by titration with titanium trichloride in the presence of sodium citrate or sodium bicarbonate. Orange I may be titrated in the presence of sodium citrate, sodium bicarbonate, or the tartrates, except potassium antimony tartrate. The correct buffer salt must be determined for each dye."

GARDNER, D. Paints, enamels, japans, etc. U. S. Patent 1662741, March 13, 1928. *Chem. Abs.*, vol. 22, April 20, 1928, p. 1485.

"An anhydrous colloidal lead-free paint, enamel, japan or like composition, contains a pigment (such as TiO_2 and titanium 'trioxide') comprising a base constituent and at least one filler constituent in which the oxide of the base constituent is positively charged relatively to the charge carried by the oxide or oxides forming the filler; all the constituents introduced into the vehicle may be compounds of the same metal as that in the case. Titanium borate may be used as a drier."

GESTETNER, D. Stencil sheet. U. S. Patent 1664675, April 3, 1928. *Chem. Abs.*, vol. 22, May 20, 1928, p. 1822.

"A white titanium pigment is used in the coating applied to yoshino or similar paper, the coating may also contain gellatin and glycerol."

GILMORE, L. E. Effect of various elements on malleable cast iron. *Trans. Am Foundrymen's Assoc.*, vol. 36, 1928, pp. 287-292. *Chem. Abs.*, vol. 22 July 20, 1928, p. 2535.

"The elements present in ordinary malleable iron are: Iron, phosphorus, manganese, sulphur, silicon and oxygen. In solution phosphorus is harmless, but iron phosphide causes brittleness and loss of strength. The manganese-sulphur ratio must be carefully controlled with manganese in slight excess, but the absolute amounts are not so important. Low carbon with high silicon makes the strongest and most ductile iron. Titanium, nickel, uranium and zirconium act like silicon in precipitating carbon. Inhibitors of graphitization are abnormal amounts of sulphur or manganese and antimony, boron, cerium, chromium, molybdenum, selenium, tellurium, tin and vanadium. Malleable iron should be regarded as a mixture of compounds and interacting elements which, when properly balanced, determine the quality of the iron."

INDUSTRIAL AUSTRALIAN AND MINING STANDARD. Tasmania's mineral industry. IX. Paint materials. Vol. 80, 1928, p. 227.

As in most countries, rutile and ilmenite are found in small quantity at various places. The principal deposit is that at Naracoopa, King Island, at the mouth of the Fraser River. The sea sand here contains ilmenite, SnO_2 , gold, monazite, molybdenite, etc., ilmenite and SnO_2 being most plentiful. The enriched portion appears to be about half a chain in width, lessening toward the seashore. The depth of the deposit varies slightly, its average being about 8 feet. The surface is but 6 feet above high-water mark. The highest assay in TiO_2 from the most finely divided material of the magnetic product of the sand is 44.88 per cent. The results of some tests carried out on the black sand are appended below:

	Magnetic product, per cent	TiO_2 , per cent	Fe, per cent
On 60 mesh.....	3.12	11.80	6.93
On 80 mesh.....	29.68	30.16	14.10
On 100 mesh.....	34.37	43.52	21.53
On 120 mesh.....	20.32	44.56	26.23
Through 120 mesh.....	12.51	44.88	33.66

The land is held under lease 9620/M at present in the name of J. McK. Bowling.

The Arthurs Lake deposit consists of ilmenite and quartz sand and covers the floor of the upper lake. An analysis of a clean ilmenite concentrate yielded 25.75 per cent of titanium.

— Vol. 79, 1928, p. 512.

"A substantial deposit of ilmenite, assaying 45.9 per cent of titanium oxide, is reported to have been discovered within 40 miles of Melbourne, and the owner is endeavoring to secure its commercial exploitation."

JOHNSON, J. Y. Destructive hydrogenation of carbonaceous materials. British Patent 300703, 1928. Chem. Age (London), vol. 19, December 22, 1928, p. 589.

"Catalysts for the hydrogenation of coal, tars, mineral oils, distillation, extraction, and conversion products at high temperature and pressure consist of boron, silicon, titanium, vanadium, tantalum, molybdenum, or tungsten, either free or combined, or cobalt in a combined state, together with not more than 10 per cent of copper and zinc (or cadmium) either in a free or combined state. The pressure is above 50 atmospheres and the temperature above 400° C. A large excess of hydrogen is employed or mixtures or compounds containing hydrogen may be used. The apparatus is preferably composed of or lined with aluminum or steel alloys. The carbonaceous material is exposed in thin layers on porous supports, through which the hydrogenating gas passes, or the liquid material may be sprayed into the gas."

LEHMANN, K. B., and HERGET, L. Hygienic properties of titanium dioxide and "titanium white." Chem. Ztg., vol. 51, 1927, pp. 793-794. Chem. and Ind. (London), vol. 47, February 3, 1928, p. 100.

Titanium dioxide proved harmless when administered to cats, rabbits, etc., over periods up to 16 months, and titanium white is considered to be a perfectly nonpoisonous pigment. Methods for the analytical determination of titanium are described.

LUBOWSKY, SIMON J., assignor to Metal & Thermit Corporation. Method of transforming titanium-dioxide or rutile and a product thereof. U. S. Patent 1640952, August 30, 1927.

"Rutile, ground to 150 mesh, is intimately admixed in a pebble mill with magnesium oxide, preferably dead-burned magnesite, in about equal weights. The mixture is then transferred to a kiln, furnace, or crucible and heated to approximately Seger cone 18, until a hard semivitreous mass is obtained. The calcined mass is then ground to about 150 mesh or finer and heated in a digester to approximately 90° C. with sulphuric acid, in the proportion of about 2½ parts acid to 1 part of the calcined product by weight, the digesting mass being stirred or agitated. This produces an exothermic reaction and the sintered product combines with the sulphuric acid and forms a cake. Water is then added in the proportions of about 2 parts by weight to 1 part of the sulphuric acid employed and the whole stirred until a clear brownish solution is obtained, which solution contains the titanium values in proper form to be converted into whatever titanium compound may be desired. For example, by filtering the solution and boiling the filtrate, a brilliant white precipitate of meta-titanic acid is obtained, which, when calcined, is converted into pure titanium-dioxide of an extremely fine texture and excellent covering qualities."

MEIER, C. Ferrous alloy. U. S. Patent 1662158, March 13, 1928. Chem. Abs., vol. 22, April 20, 1928, p. 1321.

"An alloy adapted for casting in permanent steel molds comprises iron together with carbon 2-4, silicon 2.5, 60 per cent chromium 1-3, titanium 1-3, aluminum 0.5-1.0, manganese 0.5-3.0 and phosphorus 0.25-1.0 per cent."

OSBORNE, F. F. Certain magmatic titaniferous iron ores and their origin. Econ. Geol., vol. 23, 1928, pp. 741-745.

PILLING, N. B., and SCHOENER, J. G., assignors to International Nickel Co. (Inc.). Welding rod. U. S. Patent 1679003, July 31, 1928. Chem. and Ind. (London), vol. 47, October 12, 1928, p. 758.

"A welding electrode comprises a nickel rod rendered malleable by the addition of an alkaline-earth metal and coated with a mass containing a titanium alloy and a calcium alloy in such proportions that the titanium in the coating is 0.1-10 per cent and the calcium 0.1-8 per cent of the weight of the electrode."

RUDGE, ERNEST A., and ARNALL, FRANCIS. "Titanium cyanonitride" and the titanium oxychlorides. *Chem. and Ind. (London)*, vol. 47, 1928, pp. 376T-380T.

"The copper-colored crystalline compound of titanium produced during the blast-furnace process for the manufacture of iron is titanium nitride, of the empirical formula TiN . It is intimately admixed with graphite, a circumstance which has probably given rise to the fact that it has been regarded as a cyanonitride of the formula $Ti(CN)_2 \cdot 3Ti_3N_2$ (Wöhler, 1850).

"The crystalline compound obtained by the action of chlorine on this substance is an oxychloride of titanium and not a cyanochloride, $2TiCl_4, CNCl$. The constitution of the oxychloride is correctly represented by the formula $3TiCl_4, TiO_2$."

SPENCE & SONS (LTD.). Preparation of titanium compounds and pigments. British Patents 290683 and 290684, November 17, 1926. *Chem. and Ind. (London)*, vol. 47, August 3, 1928, p. 568.

"Titanium phosphate is prepared by addition of a soluble phosphate to a solution of a titanium salt containing more than 10 per cent of titania and more than 15 per cent of free sulphuric acid or its equivalent. To obtain a precipitate that filters readily, a temperature of 50° must not be exceeded. Titanium phosphate is converted into hydroxide or oxide by heating with alkali carbonates or hydroxides either in aqueous solution or in powder form. The soluble alkali phosphate is removed by leaching. To obtain colored pigments, the titanium phosphate may be calcined with salts of a colored base with a volatile acid—e. g., ferrous sulphate for red pigments or barium sulphate and ammonium dichromate for green pigments."

STANSFIELD, ALFRED. Smelting titaniferous ores of iron. *Emp. M. & M. Cong. Proc.*, 1927, pp. 552-569.

VINASSA, PAOLO. Molecular number. *Gazz. chim. ital.*, vol. 58, 1928, pp. 178-180. *Chem. Abs.*, vol. 22, July 20, 1928, p. 2499.

"In drawing the general conclusion that nearly all compounds, whether natural or synthetic, organic or inorganic, have even molecular numbers, certain important exceptions must be recognized. Among inorganic compounds with uneven molecular numbers, compounds of manganese, cobalt, chromium, copper, cerium, molybdenum and iron predominate, with a few compounds of titanium, iridium, mercury, chlorine, phosphorus, nitrogen, tin, nickel, ruthenium, vanadium, tungsten, uranium, gallium, neodymium, and praseodymium. Only a small proportion of the elements form compounds with uneven molecular numbers. Extremely few organic compounds have uneven molecular numbers."

TUNGSTEN UNITED STATES

In 1928 tungsten miners of the United States sold an equivalent of 1,208 short tons of concentrates carrying 60 per cent of tungsten trioxide (WO_3) for \$753,900, and of these sales, 180 tons came from stocks. Very little stock was held at the end of 1928, and the production for the year was somewhat less than the sales in 1927, which amounted to 1,164 tons, valued at \$724,000. Tungsten ore was produced and sold in 1928 by 12 companies. Eight of these companies, employing 210 men, produced 93 per cent of the total output.

The tungsten production of the United States during the last 10 years has been as follows:

Concentrated tungsten ores (reduced to equivalent of 60 per cent WO_3) produced in the United States, sold in 1919-1928, and average price per unit

Year	Short tons	Value	Average price per unit	Year	Short tons	Value	Average price per unit
1919-----	327	\$353,900	\$18.02	1924-----	2565	² \$287,000	\$8.47
1920-----	216	101,800	7.86	1925-----	1,191	755,500	10.57
1921-----				1926-----	1,382	920,400	11.10
1922-----				1927-----	1,164	724,000	10.37
1923-----	241	144,600	10.00	1928-----	1,208	753,900	10.40

¹ The output of 1923 was made by one company only, which sold to its owners at a price considerably above the market.

² Includes 191 tons produced in 1919, sold in 1924 for \$87,000.

Prices in the United States ranged between \$10 and \$11.25 for concentrates of good quality. Many tons of concentrates contained only 28 to 55 per cent of WO_3 , and prices for the lower grades were as low as \$4.25 per short ton unit (20 pounds of WO_3). World prices ranged from \$3.25 to \$4 per long ton unit (22.4 pounds of WO_3) for concentrates carrying 65 per cent or more of tungsten trioxide.

Arizona.—In Arizona the Minerals Conversion Co. of Los Angeles erected a small mill in the Tip Top district, and a little wolframite was produced; the Tungsten Production Co. (Inc.) of Boulder, Colo., did some prospecting for scheelite in the Huachuca Mountains, and Edward C. O'Brien & Co. erected a small mill at Globe to treat the tungsten ores of the region.

California.—The Atolia Mining Co. worked the low-grade residual placer deposits and the dumps from the East Union mine at Atolia. The placers carry only about 2 pounds of concentrates per cubic yard, and the East Union dumps yield about 10 pounds of concentrates per ton. Such material, of course, can be made to pay only by expert operation. During the year the Capitola Mining Co. also did a little work near Atolia. Cooper Shapley was in charge of work on the tactite deposits at Round Valley, near Bishop, and some production of scheelite was made. Beauregard Bros. prospected a scheelite deposit in the Chedago district, 20 miles north of Bishop.

Colorado.—Near Nederland, Boulder County, the Tungsten Production Co. (Inc.), the Wolf Tongue Mining Co., the Clipper Tungsten Co., the Molybdenum Corporation of America, George W. Teal, and the Ferberite Tungsten Mines (Inc.) all operated, at least part of the year. It is probably fair to say that most of the work done during the year was prospecting for new ore bodies. Nearly all of the known ore bodies have been worked out, and so far no large bodies have been found.

Missouri.—The Ozark Tungsten Co. and Edward C. O'Brien & Co. mined a little wolframite in sec. 23, T. 33, R. 5 E., Madison County, about 10 miles west of Fredericktown.

Nevada.—The Nevada-Massachusetts Co., in the Eugene Mountains 12 miles northwest of Mill City, was the largest producer of tungsten concentrate in the United States in 1928, as it has been for several years past. The ore is tactite (a contact metamorphosed limestone) carrying scheelite. The concentrates are of high grade and carry about 70 per cent of WO_3 . About 50 men were employed in the mine and 12 around the mill. Alex Ranson sold some scheelite mined in 1927 from a vein, the Silver Dyke, 9 miles southwest of Mina. As the water supply was inadequate to continue operations, he moved to a deposit near Quartz Mountain in which the Nevada-Massachusetts Co. is also interested; this deposit contains a peculiar gray scheelite replacing limestone. The company and Mr. Ranson are reported to have purchased from Garrett Smith a tungsten deposit on Jew Mountain, 43 miles northeast of Luning.

The Tungsten Production Co. (Inc.), of Boulder, Colo., did some work on the tactite on the east side of the Nightingale Mountains, which follow the east shore of Lake Winnemucca.

South Dakota.—The Homestake Mining Co. continued work on its wolframite deposits at Lead until November 1, when the mine was exhausted. Prospecting in the vicinity of the old Wasp No. 2 mine on Yellow Creek, 2 miles south of Lead, is understood to have given little encouragement.

IMPORTS

The imports of tungsten during 1928 were larger than those in any other year since the present tariff went into effect, September 22, 1922. During the year the United States imported 2,855,990 pounds of tungsten in concentrates (equivalent to 3,001 short tons of concentrates carrying 60 per cent of WO_3), valued at \$672,199, or \$3.73 per short-ton unit, and 112,849 pounds of tungsten in ferrotungsten and other forms (equivalent to about 119 tons of concentrates carrying 60 per cent of WO_3)—a total of 3,120 tons of 60 per cent concentrates. The quantity imported (3,120 tons) plus the domestic sales (1,208 tons) indicates an apparent new supply of 4,328 tons of tungsten concentrates, of which the United States furnished 28 per cent.

The imports of tungsten in various forms during the past 10 years are shown in the following table.

Tungsten ore, ferrotungsten and tungsten metal, tungsten alloys, and tungsten chemicals imported for consumption in the United States, 1919-1928¹

Year	Tungsten ore and concentrates ¹		Tungsten and ferrotungsten, tungsten chemicals, powder, and acid ¹		Ferrochromium-tungsten, chromium-tungsten, chromium-cobalt-tungsten (W content)		Tungsten-nickel and other alloys of tungsten (W content)	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919.....	18, 816, 000	\$6, 261, 190	396, 460	\$287, 981	-----	-----	-----	-----
1920.....	3, 897, 600	779, 593	1, 997, 719	1, 180, 829	-----	-----	-----	-----
1921.....	3, 227, 840	276, 757	507, 206	180, 371	-----	-----	-----	-----
1922:								
Jan. 1-Sept. 21.....	3, 301, 760	279, 190	1, 037, 069	380, 732	-----	-----	-----	-----
Sept. 22-Dec. 31.....	-----	-----	30, 876	13, 254	-----	-----	885	\$741
1923.....	-----	-----	78, 972	25, 907	-----	-----	49	2, 258
1924.....	-----	-----	132, 987	46, 156	8, 800	\$2, 702	71	536
1925.....	854, 059	206, 326	839, 194	316, 454	396	352	-----	-----
1926.....	2, 534, 636	566, 996	330, 365	116, 879	18, 795	7, 822	71	417
1927.....	2, 170, 657	540, 409	27, 272	9, 777	66	377	56	328
1928.....	2, 855, 990	672, 199	112, 474	46, 552	71	1, 753	304	2, 544

¹ Prior to Sept. 22, 1922, imports recorded as ore, alloys, etc.; beginning with change in tariff, recorded as tungsten content of ore, alloys, etc.

On April 9 the United States Court of Customs Appeals on an appeal from the United States Customs Court ruled that:² "Steel bars containing tungsten only and not molybdenum and tungsten are not subject to the additional rate of duty of 72 cents per pound. The phrase 'molybdenum and tungsten' can not be construed as if it read 'molybdenum or tungsten.' The language of the proviso is plain, unmistakable, and unambiguous and will result in no absurdity or conflict with any other part of the statute, if given the definite meaning which its words import. The second proviso is therefore not open to interpretation, and its meaning and purpose must be determined by the words, terms, and expressions in which the legislative will was expressed," thus reversing the lower court.

On April 20 the Senate adopted a resolution introduced by Senator Tasker L. Oddie requesting an investigation "forthwith into the costs of production of tungsten in the United States and China, the principal competing country, and to report its findings to the President

² Treasury Decisions, vol. 53, Apr. 26, 1928, p. 66.

of the United States." Although the investigation was quickly begun, no report was made up to the end of the year.

During 1928 a few hundred tons of scrap steel carrying tungsten was imported, all with a value below 7 cents a pound, to which limit a duty of 75 cents a ton applies. Some scrap valued at between 7 and 8 cents a pound, on which a duty of 10 per cent was levied, was also imported. The tungsten content as shown by analyses of samples made by the Bureau of Customs ranged from 1.5 to 12 per cent of W. Efforts are being made to have the tungsten-bearing scrap declared a tungsten steel which should pay a duty of 8 per cent ad valorem, and also a duty of 72 cents per pound levied on the tungsten content in excess of six-tenths of 1 per cent.

HARD TUNGSTEN ALLOYS

Tungsten carbide for tools such as lathe tools and drills for oil wells attracted much attention during the year. Several carbides of tungsten are known; that containing about 6 per cent of carbon (WC) is apparently the hardest. Upon solidifying, however, this carbide is always more or less porous and very brittle. For years unsuccessful efforts have been made to toughen it so as to make practical use of its great hardness, which lies between that of the sapphire and the diamond. Many methods have been tried. By one process the powdered carbide is placed in a graphite tube and then sintered between two graphite electrodes used as plungers. By another tools are cast from the carbide and then soaked in molten iron, nickel, or cobalt to fill the pore space. In what seems to be the most successful method, apparently covered by a patent issued to the Krupp Co.,³ the carbide is produced in exceedingly fine grains and then ground with or without 4 per cent powdered cobalt to a diameter of 0.0001 mm. (one twenty-five thousandths of an inch). If the cobalt is not added at first, long further grinding is required to mix it with the carbide. If ground in an iron mill, iron is automatically added by the wear of the mill. The material is finally pressed into shape, sintered, and ground to form. Tungsten carbide is understood to be marketed under the names of borite, carboloy, dimondite, hastellite, sulamite, triamant, and others. For tipping tools the carbide must be cemented to the steel body by the atomic hydrogen blowpipe or some other nonoxidizing means. Copper is ordinarily used to make the bond. Grains of tungsten carbide are set in drill bits for soft rocks and used instead of diamonds. When finished, the tungsten carbide appears quite as metallic as the other part of the tool. Properly made tungsten carbide tools will cut chilled castings, rough sand castings, unevenly tempered steel, glass, porcelain, and even quartz. It will cut at high speeds hard rubber, bakelite, and mycalex (fine mica in lead borate), which quickly destroy the edges of other high-speed tools.

Tungsten carbide tools seem to represent the greatest advance in metal-cutting tools since the invention of high-speed steel. They have not as yet proved easy to manufacture, however. The purity of the tungsten carbide, the fineness of its grain, and the production of a solid fine-grained mass after sintering all give more or less trouble. In addition, cementing of the cutting tips to steel holders by copper

³ Friederich Krupp Aktiengesellschaft, Sintered Hard Metal Alloys and Articles Manufactured Thereof: British Patent 278955, Oct. 20, 1927.

or some other metal is difficult, and under high-speed cutting the bond sometimes gives way. All of the difficulties together have made manufacture somewhat uncertain and very expensive.

RECOVERY OF SCHEELITE FROM SLIME TAILINGS

During the year H. A. Doerner, of the Bureau of Mines experiment station at Reno, Nev., continued experiments on saving scheelite from slime tailings in the Eugene Mountains near Mill City, Nev., by means of a centrifuge. About 50 per cent of the scheelite was saved when the machine was adjusted to make a concentrate containing 20 per cent of WO_3 . Higher recoveries may be expected by making a lower-grade rougher concentrate and recleaning it in a second machine. The 20 per cent concentrate is readily cleaned to contain more than 70 per cent of WO_3 by floating off the sulphides and by finally treating on a gravity slime table. Losses in cleaning are small and can be nearly eliminated by sending rejects to the centrifuge. The method has not yet been used in an actual commercial installation.

WORLD PRODUCTION

China continued to be the most important of the tungsten-producing countries. In Burma and the Malay Peninsula tungsten concentrates were produced as a by-product of tin mining. In Bolivia some tungsten was mined toward the end of the year.

The figures available on world production from 1919 to 1928 are shown in the following table.

World production (as shown by sales or exports) of tungsten ore, 1919-1928, by metallogenic provinces and political areas, in metric tons of concentrates containing 60 per cent of WO_3

Province and area	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
ASIA										
Japo-Korean province:										
Japan.....	574	170						19	49	(¹)
Chosen (Korea).....	197	5	(²)	14	(¹)	(¹)	(¹)	(¹)	³ 300	161
Chino-Malayan province:										
China.....	2,654	4,712	2,657	3,873	4,554	3,398	6,708	7,989	5,666	8,283
Tonkin (Indo-China).....	284	284	452	112	129	150	189	92	213	211
Burma and Shan States.....	3,623	2,983	673	1,038	960	814	849	1,634	1,277	1,760
Siam.....	258	137	76		(²)		127	10	8	(¹)
Unfederated Malay States.....	808	296	12	258	393	214	251	234	170	139
Federated Malay States.....	480	257	60	104	41	107	174	99	22	5
Netherland East Indies.....		161	80		10	165	27	9	9	8
Indian province: India (excluding Burma).....	1									(¹)
	8,879	9,005	4,010	5,399	6,087	4,848	8,325	10,086	7,714	(¹)
AUSTRALIA										
Australian province:										
Queensland.....	344	119	5	4		1	5	1	3	29
Northern Territory.....	278	245		19	1					
New South Wales.....	237	39			2	10	8			
Victoria.....	3	9								
Tasmania.....	379	209	12	21	116	64	207	98	176	209
Western Australia.....	8	3								
	1,249	624	17	44	119	75	220	99	179	238

¹ Data not available.

² Less than one-fourth ton.

³ Estimated.

World production (as shown by sales or exports) of tungsten ore, 1919-1928, by metallogenic provinces and political areas, in metric tons of concentrates containing 60 per cent of WO_3 —Continued

Province and area	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
OCEANIA										
Oceanic province: New Zealand.....	146	47	46	-----	15	18	36	15	15	6
SOUTH AMERICA										
Cordilleran province:										
Argentina.....	204	182	52	125	144	137	4	11	10	24
Bolivia.....	2,161	766	174	9	-----	(¹)	82	109	79	29
Peru.....	139	77	2	-----	-----	-----	5	-----	-----	-----
	2,504	1,025	228	134	144	137	91	120	89	53
NORTH AMERICA										
Southwestern American province:										
Mexico.....	103	82	37	-----	-----	-----	-----	-----	-----	-----
United States.....	297	196	-----	-----	219	513	1,080	1,254	1,056	1,066
	400	278	37	-----	219	513	1,080	1,254	1,056	1,096
EUROPE										
Scandinavian province:										
Sweden.....	30	5	-----	-----	-----	-----	-----	-----	-----	(¹)
Franco-Cornish province:										
England.....	177	83	81	3	2	2	1	20	12	96
France.....	70	23	-----	-----	-----	-----	-----	26	22	5
Iberian province:										
Portugal.....	706	237	306	527	289	304	207	358	179	(¹)
Spain.....	302	57	25	-----	9	161	26	123	164	158
Italy.....	(¹)	-----	7	-----	1	-----	-----	-----	-----	-----
Erzgebirge province:										
Germany.....	145	45	27	42	40	13	161	-----	-----	(¹)
Czechoslovakia.....	70	48	35	28	28	66	60	86	78	73
Russian province: Russia.....	5	(¹)	(¹)	(¹)	(¹)	(¹)	9	[§] 63	[§] 44	(¹)
	1,505	498	481	600	369	546	464	676	499	(¹)
AFRICA										
South African province:										
Southern Rhodesia.....	20	17	17	44	-----	22	22	-----	33	15
Union of South Africa.....	9	-----	-----	-----	-----	-----	-----	-----	-----	-----
Nigeria.....	32	-----	-----	-----	-----	-----	-----	-----	-----	-----
	61	17	17	44	-----	22	22	-----	33	15
	14,744	11,494	4,836	6,221	6,953	6,159	10,238	12,250	9,585	(¹)

¹ Data not available.

⁴ Less than one-half ton.

[§] Year ended Sept. 30.

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BINNIE, D. Measurement of high temperatures by means of a tungsten-molybdenum thermocouple. Jour. Roy. Tech. Coll. Met. Club, Glasgow, vol. 6, 1927-28, pp. 35-36, 42. Chem. and Ind. (London), vol. 47, December 21, 1928, p. 915.

"A tungsten-molybdenum thermocouple may be used for temperature measurements up to 2,000° provided that oxidation is avoided by passing a current of hydrogen through the furnace or through the protecting tube of the couple. The thermoelectric curve is almost a parabola with the equation $y=0.151x^{2.125}$, the neutral temperature occurs at 618° when the E. M. F. of the junction is 1.36 millivolts and the reversal point at 1,218° using a cold junction at 18°. Above the reversal point tungsten is the electropositive metal. The tungsten wire should not exceed 0.4 mm. in diameter nor the molybdenum wire 0.64 mm."

BURK, ROBERT E. The thermal decomposition of ammonia upon mixed surfaces of tungsten and platinum. *Proc. Nat. Acad. Sci.*, vol. 14, 1928, pp. 601-602.

"'Surface alloys' were produced by evaporating one metal from a spiral on to a filament of the other metal mounted axially within it.

"Not only did the mixed surface cause a greater velocity of decomposition than the same area of either platinum or tungsten alone, over the whole range of temperature investigated, but the temperature coefficient was decidedly smaller for the mixed surfaces, in complete agreement with expectations on the basis of mechanism."

CARPENTER, H. C. H. Alloy steels—their manufacture, properties, and uses. *Chem. News*, vol. 136, May 18, 1928, pp. 307-310.

"Mushet's air-hardened steel, * * * in addition to 6 per cent of tungsten, contained about 2 per cent of manganese and 2 per cent of carbon. The manganese was required to give the steel the self-hardening property. Actually, therefore, it was a quaternary steel. Special interest attaches to it in view of the fact that it was the pioneer among alloy steels. It had a remarkable career of usefulness and formed an indispensable link in the development of high-speed tools. For some time it has been practically obsolete.

"Iron melts at 1,535° C. The addition of carbon lowers the melting point about 100° C. for every 1 per cent addition of carbon. Tungsten is the most refractory metal known, but it is generally considered that it lowers the fusion point of steel. Mars has given a table of the fusion points of tungsten steels ranging from 0.5 to 17 per cent tungsten from which he has drawn this conclusion. If, however, his results are corrected for the lowering effects of the carbon, silicon, and manganese present in the steels, some doubt arises as to whether this conclusion is correct. Thus, a steel which contained 0.66 per cent carbon, 0.3 per cent silicon, 0.04 per cent manganese, and 3.11 per cent tungsten fused at 1,488° C. The carbon would lower the fusion point about 60° C., and the effect of the silicon and manganese would be inappreciable, so that the plain iron tungsten alloy should fuse at about 1,548° C., which is 13° above that of pure iron. This appears to be the effect of 3.11 per cent of tungsten and it is not a lowering but a raising of the fusion point. Considering the refractoriness of tungsten, it may well be doubted whether it does really lower the fusion point of iron.

"Special care is required in charging the pots owing to the great difference between the specific gravity of tungsten (19.3) and of steel (about 7.6). The tungsten is placed at the top of the charge and is gradually dissolved by the steel which melts long before it. If the tungsten were originally placed at the bottom of the crucible, an infusible mush of rich tungsten alloy would form, which would neither pour out nor mix with the steel. Special care, therefore, is needed to get the tungsten melted and evenly dissolved.

"Plain tungsten steel finds application in permanent magnets for electric meters, in small dynamos, and for hand use. By far the greater part of the annual production consists of a steel containing about 6 per cent of tungsten and from 0.16 to 0.75 per cent of carbon. To obtain the best magnetic qualities, it must be heat-treated and therefore all magnet steels are used in this condition. The process involves two operations: (1) The steels are hardened by heating and quenching in water at 850° C.; (2) they are then magnetized, and if they are to be used for electric meters they are 'seasoned' by a protracted heating at 100° C., so as to make their magnetism as nearly constant as possible."

CISSARZ, A. Uebergangslagerstätten innerhalb der intrusivmagmatischen Abfolge. Teil 1. Zinn-Wolfram- und Molybdänformationen. (Transition deposits within the sequence following magmatic intrusion. Part 1. Tin-wolfram and molybdenum intrusions.) *Neues Jahrb. Mineral., Geol., Paläont., Beilage-Bd. 56*, part A, 1927, pp. 99-274.

ENGLE, E. W. The gaseous reduction of tungsten and molybdenum oxides. *Trans. Am. Electrochem. Soc.*, vol. 51, 1927, pp. 397-401.

The reductions are carried on by a stream of hot hydrogen in a silica tube furnace. The consumption of hydrogen when allowed to burn freely at the end of the tube is 385 cubic feet (10,900 liters) per kilogram of powder. This probably could be reduced by better control. In a closed system the consumption of hydrogen was 100 cubic feet (2,832 liters) per kilogram of powder.

In another system, in which the cooling at the end of the reduction was much more rapid, the hydrogen consumption averaged 33 cubic feet (934 liters) per kilogram of powder. The theoretical consumption is 12.85 cubic feet (364 liters) per kilogram of tungsten powder. Reduction begins at 620° C. In the one

system the furnace is brought to 950° C. in about two hours and held there until the end of reduction, averaging three hours, and then cooled. Less than 0.02 per cent of reducible oxygen remains. The powder passes 200 mesh. Molybdenum is reduced in the same way, but there is a tendency for the metal to cake on the surface and to allow only very slow penetration of hydrogen through the mass. Moreover, it uses more hydrogen for the same weight of material. Reduction begins at about 300° C. and can be completed at about 625° C., but better practice brings the reaction nearly to completion at about 850° C. The metal is then cooled, repacked in the furnace, and reduction is completed at 1,100° C. in several hours. The remaining oxygen content is less than 0.05 per cent. No continuous process is known to have been developed. The relatively small quantities of the metals used in the very pure form, the extreme necessity of preventing contamination, the need of temperatures of 1,000° C., and the simplicity of intermittent tube production have all deterred the development of continuous processes.

FONDS, G. R. Evaporation of tungsten under various pressures of argon.

Phys. Rev., vol. 31, 1928, pp. 260-266. Chem. Abs., vol. 22, May 10, 1928, p. 1509.

"A theory of the evaporation of a heated tungsten filament immersed in an inert gas is developed in which it is assumed that the evaporating atoms diffuse through a film of stationary gas surrounding the filament. The diameter of the film is calculated from Langmuir's equation for the heat loss from a filament. The theory leads to the relation $maP \log b/a = \text{const.}$, where m is the rate of evaporation, P the pressure, and a and b are the diameters of the filaments and gas film, respectively. In testing the theory the rate of evaporation of a tungsten filament at 2,870° K in a gas mixture, 86 per cent A, 14 per cent N₂ was measured. From the loss in weight of the filament for various gas pressures the rate was calculated. The rates varied from 230×10^{-9} grams per square centimeter per second in a vacuum to 2×10^{-9} grams per square centimeter per second at a pressure of 165 centimeters. It is shown that when b is calculated from Langmuir's equation for heat loss the expression $maP \log b/a$ is actually constant for gas pressures in excess of 10 centimeters. The fact that the round filaments developed a hexagonal cross section in accord with the normal crystal shapes of tungsten grains is evidence of the backward diffusion of evaporated metal with consequent condensation on the filament."

FRANKLIN, NELSON. The tungsten industry. Min. Cong. Jour., vol 14, 1928, p. 319.

A plea for a higher duty on imported tungsten.

GEISS, W., and VAN LIEMPT, J. A. M. Atom deformation in worked metals. Ztschr. Physik, vol. 45, 1927, pp. 631-634. Chem. Abs., vol. 22, March 20, 1928, p. 895.

"Investigation of the change of the electrical conductivity of pickled tungsten filaments show that work done in the cold (hammering, stretching, rolling) deforms the atom."

GERO, W. B., and IREDELL, C. V. Making pure tungstic oxide involves many unusual plant problems. Chem. and Met. Eng., vol. 35, 1928, pp. 412-417.

The different methods of decomposing wolframite are discussed. The Westinghouse process uses Chinese wolframite containing 65 to 75 per cent of WO₃. The wolframite is crushed until all will pass a 100-mesh sieve and 80 per cent will pass a 200-mesh sieve. It is digested in boiling caustic soda solution. The sodium tungstate is decanted and the insoluble residue washed with water. Calcium tungstate is precipitated by adding calcium chloride to the solution. The suspended CaWO₄ is run into an excess of boiling HCl and yellow or orange H₂WO₄ is precipitated. The H₂WO₄ slurry is run into an excess of ammonia and dissolved. The solution is neutralized with pure HCl, forming ammonium paratungstate crystals (fine white needles). The crystals are ignited, leaving pure WO₃. The plant needed for the process is described. A typical analysis of the Chinese wolframite is:

Composition	Per cent	Composition	Per cent
WO ₃ -----	71.16	As.-----	0.07
Mn.-----	7.29	P-----	Trace.
Fe.-----	11.72	Mo-----	Trace.
SiO ₂ -----	1.49	Sn-----	.29
Al ₂ O ₃ -----	.52	S-----	.14

Typical analyses of purified tungstic oxide are:

Composition	Lot No. 1, per cent	Lot No. 2, per cent	Composition	Lot No. 1, per cent	Lot No. 2, per cent
WO ₃ -----	99.982	99.990	Fe-----	0.001	0.001
SiO ₂ -----	.002	.003	Na ₂ O+K ₂ O-----	.007	.004
CaO-----	.004	.000	Mo-----	Trace.	Trace.

HOYT, S. L. Carbology—another new tool material developed. Eng. and Min. Jour., vol. 126, November 24, 1928, p. 838.

"A new kind of machine-tool material has recently been announced by Dr. S. L. Hoyt, of the General Electric Research Laboratory. It is known as 'Carbology' and is composed of tungsten carbide and cobalt, the carbide making it extremely hard and the cobalt giving it the necessary strength for cutting tools. Its possibilities were indicated by the following, according to Dr. Hoyt: Cobalt-chromium alloy cutters, which had given the best previous service in cutting gears, required redressing for every 150 parts machined; the new tungsten carbide tools, operating under identical conditions, finished 11,000 parts before requiring sharpening. The new material is said to retain its strength and hardness at elevated temperatures to a remarkable degree."

INDUSTRIAL AUSTRALIAN AND MINING STANDARD. Tasmania's mineral industry Vol. 80, 1928, p. 29.

The only scheelite deposit is that at the mouth of Grassy River in the south-east part of King Island. It is tacite and when opened up was 65 feet wide. It was worked from 1916 to 1921, when prices became too low for profit; 589 tons of scheelite (concentrate) was produced, valued at £112,468. Dividends of £25,000 were paid.

Wolframite is found in all the tin fields, but is economically important in only two places—the Avoca district in the northeastern part of Tasmania at Storys Creek and the Middlesex district in the northwestern part of Tasmania. The Storys Creek mine works two main veins, cutting dark slates and quartzite. The veins are 2 to 6 feet wide and are of quartz carrying wolframite, SnO₂, and pyrite erratically distributed. Wolframite and SnO₂ are in about equal quantity, and the concentrates are magnetically separated. The tungsten concentrates carry 71 per cent of WO₃ and the tin concentrates 73 per cent of Sn. From 1920 to 1927, inclusive, the mine produced 725 tons of tin-ore concentrates, valued at £176,949, and 812 tons of wolframite, valued at £73,411. Mixed tungsten-tin veins occur in the Gipps Creek area, 7 miles southwest of Storys Creek, but are less important.

In the Middlesex district in the northwestern part of Tasmania numerous lodes carry cassiterite, wolframite, and bismuth. Shepherd and Murphy mine at Moira has best showing. At least seven lodes cut quartzite and garnet rock, three of which are important. The lodes are 1,400 feet long and 6 to 30 inches wide but average 6 to 18 inches. They have been worked 1,000 feet. Cassiterite, wolframite, bismuthinite, bismutite, and bismuth are found in the lodes. The relative importance of the first three is 20:12:3. The principal gangue minerals are quartz, fluorspar, topaz, pinite, and beryl. The yield in concentrates is 1.66 to 1.787 per cent of the ore. They are magnetically separated.

To September, 1918, 71,856.5 tons of ore was milled, yielding 802.5 tons of "firsts," 347.45 tons of "seconds," 64.95 tons of slimes, 26.75 tons of picked bismuth, and 3.25 tons of picked wolframite. The plant burned in 1918; since then the production has been small.

JENCKES, EDWIN K. Pure oxides and salts of tungsten and molybdenum. Trans., Am. Electrochem. Soc., vol. 51, 1927, pp. 387-396.

Tungsten and molybdenum are used in the electrical industry in tungsten filament wire, tungsten and molybdenum filament suspension hooks in incandescent lamps, tungsten filaments and molybdenum plates in radiotrons, and tungsten contact points for ignition systems. They must be of extreme chemical purity.

Products of the four principal manufacturers show a content of total impurities falling between 0.03 and 0.048 per cent, from which it is concluded that tungstic acid having a maximum of 0.05 per cent impurities is acceptable for the manufacture of metallic tungsten. Laboratory specimens of tungstic acid may show a smaller content of impurities, but for commercial work the impurities can not be kept so low.

In addition to chemical specifications, material must conform to definite particle size and have a definite crystalline structure. The particle size may be estimated by measuring the apparent density of the material. Tungstic acids prepared by various manufacturers for reduction to metal gave densities of 8.5 to 12.5 grams per cubic inch (0.52 to 0.76 gram per cubic centimeter). These were true tungstic acid, H_2WO_4 . The requirements of manufacturers seem best filled by material with an apparent density of about 10 grams per cubic inch (0.61 gram per cubic centimeter). The apparent density may be varied by grinding. The apparent density first decreases to a minimum, then increases with continued grinding.

In the manufacture of tungstic acid and tungstates the steps are (1) grinding and decomposition of ore, (2) extraction by leaching, (3) purification of solutions, (4) isolation of tungsten as crude tungstic acid, (5) preparation of ammonium paratungstate, (6) preparation of pure tungstic acid, H_2WO_4 .

Certain tungsten ores have been found to contain traces and sometimes significant quantities of molybdenum, lead, calcium, titanium, gold, silver, zinc, selenium, and tellurium. The ordinary impurities are sulphur, phosphorus, arsenic, antimony, bismuth, copper, and tin. It is impracticable to separate molybdenum and tungsten in commercial work. The ore is ground to 100-mesh or less and either fused with soda ash or digested with boiling caustic soda solution with or without pressure. Calcium, phosphorus, arsenic, silicon, probably antimony, and possibly bismuth present decrease the yield. Ammonium paratungstate is made by dissolving the oxide in ammonium and either evaporating the solution or adding HCl , HNO_3 , or a mixture of the two. It may form a mass of acicular crystals, or it may crystallize partly as cubes, rhombohedrons, or plates. The density may vary considerably and reach 20 grams per cubic inch. For some uses tungstic oxide of such high density is satisfactory for metallic tungsten. Scheelite is ground and treated with acid direct. In roasting molybdenite the furnace temperature must be kept below 600°C . to avoid sintering and volatilization of the MoO_3 formed. The oxide is dissolved in ammonium to make ammonium molybdate. If the impurities are too high for use in making the metal, the material is worked into reagent molybdic acid and into sodium molybdate or calcium molybdate.

KRUSCH, P. Die Beziehungen der Wolframit- und Bleierzlagerstätten Westspaniens zu Graniten und zur Tektonik. (Relation of the wolframite and lead deposits of western Spain to the granites and to tectonics.) Deut. Geol. Gesell., Ztschr. Monatsber., vol. 80, No. 1-2, 1928, pp. 34-46. Econ. Geol., see Nickles, No. 210, p. 39.

MATVEEV, K. K. (The Gumbeksk tungsten deposits, South Urals, Russia.) Acad. Sci. C. R. No. 8, 1928, pp. 128-132. (In Russian.)

MINING JOURNAL (LONDON). Tin and tungsten. Vol. 163, November 17, 1928, p. 948.

"The production of tin ore in Burma decreased fractionally in 1927. * * *. The production in Tavoy and the Southern Shan States declined, while that of Mergui increased. The Mawchi Mines produced 1,466 tons of mixed concentrates, to which the proportion of 57 per cent cassiterite and 43 per cent wolfram is attributed. Although ground sluicing continues the general method of treating alluvial, a certain number of gravel pumps, in conjunction with monitors, have been introduced, and there were five dredges in actual operation. Besides this a big dam with a long pipe line is under construction. The scheme mooted last year of dredging the sea flats south of Mergui has progressed to the extent of a prospecting lien over an area of about 80 square miles of sea coast having been granted. Thus there are prospects of an enlarged output from Burma in the future. The output of tungsten ores is given as 1,160 tons of concentrates, as compared with 1,484 tons in 1926."

MORGAN, P. G. Minerals and mineral substances of New Zealand. Geol. Survey of New Zealand, Bull. 32, 1927, 110 pp., 2 maps.

(Scheelite, pp. 90-91. Wolframite, p. 107.) Scheelite has been found at numerous places, and through 1925, 2,371 long tons of concentrates had been produced. It was first mined in 1881. Wolframite is of only mineralogical importance. The literature is listed.

PIERS, HARRY. On a new tungsten (scheelite) deposit at Lower Sackville, Halifax County, N. S. Nova Scotian Inst. Sci., Halifax, Proc. and Trans., vol. 16, 1927, pp. 38-45.

Describes briefly 11 previously known occurrences of tungsten minerals and gives references to earlier literature. Also describes another scheelite deposit

then recently discovered a short distance north-northeast of the site of Fultz's 12-mile house, 2 miles north of Bedford railway station and 12 miles by road from Halifax. It is in a white quartz vein 3 to 18 inches thick in heavily bedded (quartz) probably Lower or pre-Cambrian. "A number of barrels of ore" was taken out, but little extent of the vein was shown.

SCRIVENOR, J. B. The geology of Malayan ore deposits. London, 1928, XV and 216 pp., illustrated.

Briefly describes tungsten deposits in the Malayan Peninsula.

SMITH, EDGAR F. Behavior of organic bases toward soluble tungstates. Chem. News (London), vol. 137, October 5, 1928, p. 221.

"Certain organic bases are good precipitants for the quantitative estimation of the tungstic acid content of soluble salts.

"Both forms of tungstic acid—the ordinary insoluble acid and soluble or meta acid—in their soluble salts are removed by specified bases.

"The blue color reaction occasioned by metallic zinc and hydrochloric acid in solutions of tungstates is not reliable when small amounts of the tungstic acid are present; that all filtrates from precipitates should be evaporated to dryness and the residues tested for tungsten by some more dependable reagent.

"Strong evidences are at hand that benzidine as chloride or acetate may yield a rapid and accurate means of determining tungstic acid volumetrically."

TORGASHEFF, B. P. Wolfram in the Far East. Int. Bergwirt., vol. 3, Leipzig, 1928, pp. 54-58.

PATENTS

ANJOW, K., assignor to Mitsubishi Kogyo Kaishiki Kaisha. Making metallic tungsten. U. S. Patent 1682058, August 28, 1928. Japan, May 18, 1926. Chem. and Ind. (London), vol. 47, November 9, 1928, p. 821.

Technically pure tungsten is obtained by heating the crude metal with alkali solution in a closed vessel under pressure.

BAGLEY, GLEN D. Electric vacuum furnace. U. S. Patent 1671461, May 29, 1928.

A vacuum furnace is made with a mercury seal and a tungsten or molybdenum resistor.

BLAU, F., KOREF, F., and MOERS, K. Tungsten filament. U. S. Patent 1670292, May 22, 1928. Chem. Abs., vol. 22, July 10, 1928, p. 2332.

"In order to prepare a tungsten filament which does not readily assume the macro-crystalline form when heated, the filament is subjected to the action of a fluted roller or otherwise treated to produce strains at different points along the filament sufficient to form nuclei of crystallization to promote macro-crystallization and the filament is then heated."

BRIT. THOMSON-HOUSTON Co. (LTD.), assignees of W. P. Sykes. Metal (tungsten and molybdenum) alloys. British Patent 279490, October 21, 1927. Chem. and Ind. (London), vol. 47, July 6, 1928, p. 489.

"Age-hardening alloys of iron with tungsten or molybdenum or both are prepared by heating together intimate mixtures of the constituent metals in a powdered form, such as is produced by the reduction of the oxides in hydrogen. The mixture is compressed into bars which are sintered in hydrogen above 1,440° until diffusion is complete; the bars are then quenched and aged for several days at a temperature somewhat above 600°. The solid solubility of tungsten in iron at 1,525° is about 33 per cent and at 600° about 8 per cent; that of molybdenum in iron is 24 per cent at 144° and 7 per cent at 600°. The hardness of the quenched alloys is about 200-250 and that of the aged alloys, after annealing under the correct conditions, varies from 500 to 650 according to the composition."

CARBIDE OF TUNGSTEN. The following patents refer to the manufacture of tungsten carbide:

British Patents 154937, December 7, 1920 (appl. date); 157774, April 10, 1922; 185313, March 27, 1922; 213214, September 25, 1924; 221786, February 12, 1925; 230356, March 12, 1925; 246487, February 17, 1927; 248336, February 17, 1927; 278955, October 20, 1927; 279376, January 12, 1928. Dutch Patent 10485. French Patent 547303. German Patents 401600, 419388, 420689, 427074, 434527, 443911. Swedish Patents 59497, 60037. Swiss Patent 123767. U. S. Patents 1525038, 1268495, 1343976, 1343977, 1477797, 1512191, 1549615, 1551333, 1552184, 1566534, 1593924, 1599425, 1621886, 1626726, 1631493, 1633258, 1652027.

DE GRAAFF, A. Tungsten filament. U. S. Patent 1662027, March 6, 1928. Chem. Abs., vol. 22, April 20, 1928, p. 1287.

"Filaments for incandescent lamps comprise tungsten with a small proportion of a compound of chromium or other suitable compound of one of the acid elements located in the periodic table in the right-hand half of the third horizontal column; less than 0.1 per cent of this compound is used and it serves to lessen the tendency of the filament to sag."

FINK, C. G. Form of tungsten and manufacture of same. U. S. Patent 1675486, July 3, 1928. Chem. and Ind. (London), vol. 47, November 9, 1928, p. 821.

"Tungsten slugs are mixed with a reducing agent and heated in hydrogen at high temperatures to remove the intercrystalline impurities by reduction. A tungsten which is largely crystalline results."

FISCHER, C. H., and FINK, C. G. Alliage du tungstène et son procédé de fabrication. French Patent 563097, March 14, 1927.

FRANKS, R. Alloy for welding rods. U. S. Patent 1671417, May 29, 1928. Chem. Abs., vol. 22, July 20, 1928, p. 2546.

"An alloy suitable for welding rods or electrodes comprises iron together with tungsten 1-12, chromium 25-35, boron 0.1-1.0, carbon 1-3.5, silicon 0.5-3 per cent and sufficient manganese to deoxidize the alloy. The ratio of silicon to manganese is at least 0.9."

FRIEDERICH KRUPP AKTIENGESellschaft. Sintered hard metal alloys and articles manufactured thereof. British Patent 278955, October 20, 1927.

"With carbides of tungsten, it is required to obtain a great hardness and tenacity, that their percentage of combined carbon is within the limits of 5.2 to 6.2 per cent.

"A carbide of tungsten is produced that is absolutely free from graphite and the percentage of carbon of which lies between 5.2 and 6.2 per cent, as follows: Very finely ground tungsten metal powder and finely powdered pure carbon are brought into a graphite crucible and exposed in a lighting-gas heated furnace to a temperature at which the carbon is able to migrate into the metal powder, the quantity of the carbon component being so determined that there is a slight excess thereof. The oxidizing atmosphere of the furnace causes a small portion of the carbon admixed with the tungsten metal powder to oxidize and the entire remaining quantity of carbon to be taken up in combined form by the tungsten, whilst on the contrary, when using a reducing atmosphere, the carbon would migrate only partly in combined form into the tungsten metal powder, and partly in the form of graphite. By the carburization performed in the above-described manner a carbide of tungsten is obtained which is absolutely free from graphite.

"Instead of the described carburization of the tungsten metal powder with a slight excess of carbon and in an oxidizing atmosphere, the carburization may also take place in continuous operation by means of traveling vessels in an atmosphere of streaming hydrogen. In this process the entire admixed carbon which in this case is determined to give a finished product of a content of carbon of 6.2 per cent is taken up in combined form by the tungsten metal, so that a graphiteless carbide of tungsten is secured."

GERO, W. B., assignor to Canadian Westinghouse Co. Tungsten powder manufacture. Canadian Patent 275882, November 29, 1927. Canadian Pat. Off. Rec., vol. 55, November 29, 1927, p. 2708.

"The method of obtaining tungsten powder of fine grain or particle size which comprises mixing with purified tungsten oxide between about 0.1 per cent and about 1 per cent of a compound containing cesium and reducing the oxide by means of hydrogen at an elevated temperature.

"The method of obtaining tungsten of varying grades of coarseness which comprises mixing with tungsten oxide varying percentages of a compound containing lithium and reducing the oxide by means of hydrogen at an elevated temperature.

"The method of obtaining tungsten of varying grain or particle size which comprises mixing tungsten oxide with a compound containing an alkali metal, the atomic weight of which latter is inversely proportional to the desired grain size, and reducing the oxide by means of hydrogen at an elevated temperature."

GILSON, E. G. X-ray anodes. U. S. Patent 1671953, May 29, 1928. Chem. Abs., vol. 22, July 20, 1928, p. 2496.

"One end of a metal stem which may be formed of molybdenum or tungsten is surrounded with refractory material such as tungsten powder and the latter is subjected simultaneously to heat and pressure to effect sintering."

GREGORY, MARGARET ADA. Titanium, tungsten, and tantalum. Canadian Patent 274670, October 18, 1927. Canadian Pat. Off. Rec., vol. 55, October 18, 1927, p. 2335.

"A process for the treatment of ore with acid for the recovery of titanium, tungsten, and tantalum, according to which the ore, in a finely divided form, is mixed with carbon in a sufficient quantity to reduce the iron present from the state of oxide to the metal together with a fusible alkali salt, the mixture is heated to bright redness in a closed vessel or in a neutral or reducing atmosphere, and finally the mass is treated with a weak acid.

"A process for the treatment of ore with acid for the recovery of titanium, tungsten, and tantalum, according to which 100 parts of ilmenite is mixed with 20 parts of powdered charcoal and 20 parts of soda ash, heated in a closed chamber to bright redness, then heated with sufficient 2 per cent sulphuric acid to neutralize the soda and form with the iron ferrous sulphate, and a slight excess to render the liquid faintly acid, and finally raised to and maintained at the boiling point for one hour."

HAWADIER, J. A. M. Filaments for electric incandescent lamps. British Patent 281685, December 1, 1927. Chem. and Ind. (London), vol. 47, August 17, 1928, p. 611.

"A metallic core of relatively high melting point—e. g., of tungsten—is covered with a metal of lower melting point—e. g., molybdenum—and this is coated with a material such as chalk, magnesium carbonate, which has great illuminating power at a temperature below the melting point of the metallic coating."

LEDERER, E. A. Tungsten or other refractory metals. U. S. Patent 1659205 February 14, 1928.

"A sulphide of tungsten or a similar refractory metal is heated in vacuo to effect decomposition and volatilization and removal of sulphur."

MARDEN, J. W., and CONLEY, J. E. Tungsten filaments. U. S. Patent 1665636 April 10, 1928. Chem. Abs., vol. 22, May 20, 1928, p. 1709.

"In forming filaments for electron-emission purposes, tungsten powder is mixed with a small proportion of thorium carbide, the mixture is pressed into a slug and the slug is heat-treated and worked into filament form."

PACZ, A. Tungsten alloy. Canadian Patent 276080, December 6, 1927. Chem. Abs., vol. 22, May 20, 1928, p. 1569.

"A tungsten alloy, suitable for electric incandescent lamp filaments, is produced by heating to a high temperature a mixture of a tungsten material, silicic acid, and magnesium."

RENTSCHLER, H. C., and MARDEN, J. W. Target for X-ray tubes. U. S. Patent 1625426, April 19, 1927.

The authors quote Kaye as stating that if platinum is used as 100 the values of other metals for targets or anticathodes in X-ray tubes are:

Uranium-----	125	Iridium-----	98
Thorium-----	120	Osmium-----	97
Gold-----	101	Tungsten-----	91
Platinum-----	100	Tantalum-----	90

Uranium and thorium metals are produced by heating hydrides in a high vacuum and at a high temperature so as to cause complete dissociation and sintering to solid, coherent metals. Thorium has a melting point close to 2,020° or 2,030° C. The intensity of emission of X rays from uranium and thorium is 20 to 25 per cent greater than that from platinum. Alloys or mixtures of uranium and thorium, or either of the metals with other metals, may be used for X-ray targets. If desired, X-ray tube may be filled with an inert gas, such as argon, helium, etc.

SARBEY, MAURICE D. Electric vacuum furnace. U. S. Patent 1671451, May 29, 1928.

Molybdenum or tungsten used as a resistor for electric furnace.

SCHRÖTER, F. Glow-discharge valve. U. S. Patent 1656957, January 24, 1928. Chem. Abs., vol. 22, March 20, 1928, p. 893.

"A vessel incloses a 'cold' cathode (which may be formed from iron, nickel, copper, or tungsten) and an anode of iron wire or other suitable material separated by a small unobstructed gap. The vessel is filled with argon under reduced pressure mixed with hydrogen. Nitrogen, phosphorus, carbonaceous compounds, and mercury also may be used."

SCHWARZKOPF, PAUL. Process for the production of molybdenum trioxide and tungsten trioxide. U. S. Patent 1629004, May 17, 1927.

A process for the production of molybdenum trioxide and tungsten trioxide from their ores, consisting in melting the ore and driving off the oxide vapors by means of a current of air, or of withdrawing by suction the oxide vapors evolved from the molten mass.

The resulting oxides are dense enough for the tungsten trioxide to be worked up without any difficulty for the production of filaments for electric incandescent lamps, Röntgen tubes, electron tubes, etc., and is in a purer state than has ever been obtained on a large scale or rarely even in small quantities in laboratories. The resulting molybdenum trioxide, for example, dissolves in ammonia, forming an absolutely clear solution which contains no impurities of sulphurous or sulphuric acid and is therefore actually quite pure.

SHAW, G. R., and TELLKAMP, B. F. Treating filaments of tungsten or like metals. U. S. Patent 1664136, 1928. Chem. Abs., vol. 22, May 10, 1928, p. 1551.

"Filaments such as tungsten while heated to incandescence are exposed to a gas such as hydrogen and C_6H_6 vapor which contains a nonmetal for combining with the filament; the duration of the exposure is controlled by the increase in resistance of the filament. An apparatus is described."

SHIMER, W. R., and CHRIST, R. H. Alloy steel. U. S. Patent 1659055, February 14, 1928. Chem. Abs., vol. 22, April 20, 1928, p. 1322.

"A strong and ductile steel suitable for making case-hardened articles contains chromium and tungsten which may each be present up to about 2 per cent and carbon not over 0.30 per cent."

VAN ARKEL, A. E., and DE BOER, J. H. Precipitating metals on an incandescent body. U. S. Patent 1671213, May 29, 1928. Chem. Abs., vol. 22, July 20, 1928, p. 2518.

"Hafnium may be precipitated on tungsten wire by heating the latter to incandescence in an atmosphere of hafnium iodide; similarly, other metals such as zirconium may be deposited on tungsten."

WOLFF, H., KOREF, F., and SKAUPY, F. Incandescent electric lamp. U. S. Patent 1655488, January 10, 1928. Chem. Abs., vol. 22, March 20, 1928, p. 920.

"A filling comprising hydrochloric acid and hydrogen and inert gas such as argon or nitrogen is used under sufficient pressure materially to reduce evaporation from the incandescing body which may be formed of tungsten."

RADIUM, URANIUM, AND VANADIUM

FOREWORD

For the past few years the story of radium, uranium, and vanadium, as it concerns the United States, has become shorter and shorter. In 1928 no radium was isolated in this country, and only a small quantity of radium ore was mined.

RADIUM AND URANIUM

UNITED STATES

In 1928, in the La Sal Mountains near Moab, Utah, A. W. Balsley mined and sold a few tons of carnotite carrying 5 per cent of uranium oxide, and in Montrose County, Colo., the Rare Metals Corporation mined and sold a little carnotite carrying 2.5 per cent of uranium oxide. This production was for use in therapeutic preparations. In the White Signal district, 9 miles south of Tyrone, N. Mex., Leach & Leach mined a few tons of rock carrying autunite and torbernite.

FOREIGN PRODUCTION

The radium business abroad was apparently more flourishing in 1928 than in 1927, as the Union Minière du Haut-Katanga which

mines uranium minerals at Chinkolobwe, near Elisabethville, Katanga, Belgian Congo, reported the sale of 40 grams of radium during 1928, an increase of 12 grams over 1927.⁴

Czechoslovakia continued the production of radium from pitchblende mined at Jachymov (formerly St. Joachimsthal), and since the World War has produced 14.6 grams, of which 5.5 grams has been placed at the disposal of hospitals and doctors as a loan, 1.3 grams has been sold, and 7.8 grams is on hand.⁵ The present production is at the rate of about 3 grams per year.

The French press reported that the exclusive right to develop radioactive ores in Russia had been granted to the Rjedkij Elementy;⁶ the Ferghana ores carry less than the American uranium ores, which average about 2 per cent of U_3O_8 as shipped, and competition with the Katanga ores appears difficult. The Soviet Government carried on some work on radium ores from Ferghana and had about 6 grams of radium distributed among various cities. Emanation is collected at these stations and is distributed by airplane as needed.

The discovery of torbernite ("chalcocite") deposits is reported from the Puy-de-Dôme region of France,⁷ but most of such deposits have proved to be small, so that any considerable effect on the market is not to be anticipated. A company was reported to have applied for a permit to work lead, zinc, copper, and radioactive ores in the Villefranche arrondissement, Rhone Department.⁸

In Cornwall a little intermittent work has been done for years at the South Terras Mine, but all the radium ore has come from old stope fillings. Capt. C. G. Moor reported that a little radium and polonium had been saved during the year. The present company is the British & General Radium Corporation (Ltd.), with offices in London and mine at St. Austell.

The work on the radium deposits at Olary and Mount Painter in South Australia has stopped, the ores being found to be too lean for profit.

MISCELLANEOUS ITEMS

Manufacture of apparatus for making radioactive drinking water, of radioactive pads and salves, and of luminescent watch and clock dials and house numbers has grown to considerable proportions. A number of deaths occurring among technical and manual operatives have, rightly or wrongly, been ascribed to the effects of radium and mesothorium. A conference was called late in the year by the surgeon general of the Public Health Service to consider the question of radioactive substances and their effect on health.

In the United States the price of radium was quoted throughout 1928 at about \$70,000 per gram.

IMPORTS

The imports of uranium and radium salts from 1925 to 1928 were as follows:

⁴ Mining Journal (London), vol. 164, 1929, p. 141.

⁵ Mining Journal (London), vol. 163, 1928, p. 892.

⁶ Engineering and Mining Journal, vol. 127, 1928, p. 198.

⁷ Mining Journal (London), vol. 163, 1928, p. 952.

⁸ Mining Journal (London), vol. 162, 1928, p. 806.

*Uranium and radium salts imported for consumption in the United States,
1925-1928*

Class	1925		1926		1927		1928	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Uranium oxide and salts of								
----- pounds-----	15, 290	\$18, 553	53, 411	\$46, 974	67, 692	\$58, 971	165, 378	\$145, 557
Radium salts-----grams ¹ -----	9. 27	462, 095	10. 97	548, 788	7. 259	393, 140	10. 97	566, 977
Radioactive substitutes ² -----	(3)	241	(4)	671	(4)	522	(4)	2, 913
-----		480, 889	-----	596, 433	-----	452, 633	-----	715, 447

¹ Bureau of Foreign and Domestic Commerce publishes quantities as follows: 1925, 143 grains; 1926, 169 grains; 1927, 112 grains; 1928, 169 grains.

² For 1925 classified as "Bromide of mesothorium and radiothorium"; for 1926 and 1927 reported by Bureau of Foreign and Domestic Commerce as "Radioactive substances."

³ 11.5 milligrams; recorded by Bureau of Foreign and Domestic Commerce as 0.1771 grain.

⁴ Weight not recorded.

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The following articles and patents relating to radium and uranium appeared or became available in 1928.

ALEXANDROW, S. P. Radiographien tujamunjnscher Erze. Ztschr. Krist., vol. 65, heft 1-2. Akad. Verlagsgesellschaft m. b. H. in Leipzig, 1927, pp. 141-148.

Describes the occurrence of tyuyamunite at Tyuyamuyun, Ferghana, Russian Turkestan, and gives six excellent reproductions of radiographs made by polished sections of ore. Part of the tyuyamunite is said to be colloidal.

BASHILOV, I. Y. Recovery of radium from old luminous paints. Jour. Chem. Ind. (Moscow), vol. 4, 1927, pp. 425-427.

BUREAU FOREIGN AND DOMESTIC COMMERCE. World Trade Notes on Chemicals and Allied Products. Safety measures governing use of insecticides in Germany. Vol. 2, No. 25, June 18, 1928, p. 1.

CHEMICAL NEWS. The radium mines at Jachymov. Vol. 137, 1928, pp. 226-227.

"The presence of radium in the uranium ores of Jachymov has revived the mining industry there, although not to the extent that it flourished in the sixteenth century.

"Early mining operations began in the fifteenth century and were developed especially by Count Joachim Schlik, who realized the value of the silver deposits. He attracted colonies of miners from Bohemia and Saxony to exploit the mines as fully as possible, and his Christian name became associated with this particular valley in the Ore Mountains (German, Erzgebirge; Czechoslovak, Krusny Hory), and the town became known as Joachimsthal. The silver was minted into coins which were noted for their genuine value and they were first called 'Joachimsthalers' which, however, was soon abbreviated to Thaler, a term which survives in the American dollar.

"The mines became famous and attracted, among others, Georg Agricola, who spent six years in Jachymov (1527-1533) and used much of the information he gained there in his monumental De Re Metallica.

"Gradually the silver became exhausted, and mining dwindled except for the production of small amounts of cobalt ores used in making colors. In the middle of last century the uranium ores were found to be useful in coloring porcelain, and so this mineral (pitchblende) was mined as far as the demand made it worth while reopening the old mines."

DOERNER, H. A. Notes on extraction and recovery of radium, vanadium, and uranium from carnotite. Repts. of Investigations, Serial 2873, Bureau of Mines, 1928, 12 pp.

To save Ra as a by-product in U-V ores being treated for V, the ore was roasted at 700° C., ground with hot soda solution, filtered and washed; the residue was digested with nitric acid, and soda solution was added, then barium chloride and sodium sulphate. By subsequent treatment Ra, U, and V were obtained.

EGNER, HANS. (Radioactive "fertilizers.") Medd. Contralanstalt. forsoksvasendet jordbruks No. 318; Kem. Avdel No. 36, 1925, pp. 1-26. Chem. Abs., vol. 22, March 20, 1928, p. 1008.

"Pot and field plot experiments were carried out with a Finnish radium ore which had an activity of 0.214 U, equivalent to about 15 mg. Ra per ton. No favorable effects were noticed with the ore in quantities of 1, 10, and 50 kg. per hectare. In some pot experiments where no K was added, the addition of the ore resulted in a decreased yield of oats."

FENNER, CLARENCE N. The analytical determination of uranium, thorium, and lead as a basis for age calculations. Am. Jour. Sci., 5th ser., vol. 16, 1928, pp. 369-381.

Detailed description of methods used in the various determinations.

———. Radioactive minerals from Divino de Uba, Brazil. Am. Jour. Sci., 5th ser., vol. 16, 1928, pp. 382-391.

"In a collection of radioactive minerals from Brazil specimens of monazite, a thorium mineral containing little uranium, and of samarskite, a uranium mineral nearly free from thorium, were subjected to a preliminary treatment to remove decomposition products and were then analyzed for uranium, thorium, and lead as a basis for calculations of age. With both minerals the results indicate an age of about 360,000,000 years. This is believed to be close to the correct figure, but there are uncertainties due to various causes, and especially to some question as to whether the preliminary treatment had completely removed decomposition products. These matters are discussed, and emphasis is laid on the importance in all work of this kind of seeing that decomposition products be removed as completely as is practicable."

HACQUAERT, ARMAND L. Over Pseudomorphosen in Radioactieve Mineralen van Katanga. (Some pseudomorphs of uranium minerals from Katanga.) Natuurwetenschap. Tijd., vol. 9, No. 2, pp. 34-39, en flamand plus résumé anglais, Anvers, 1927.

HAHN, OTTO. Protactinium as a radioactive and as a chemical element. Sitzb. preuss. Akad. Wiss., 1927, pp. 275-283.

HONIGSCHMID, O., and SCHILZ, W. E. (Revision of atomic weight of uranium. The analysis of uranium tetrachloride.) Ztschr. anorg. allgem. Chem., vol. 170, 1928, pp. 145-160.

JEDRZEJOWSKI, HENRI. The charge of X-rays emitted per second by a gram of radium. Ann. phys., vol. 9, 1928, pp. 128-185.

"By employing in general the method of Rutherford and Geiger the charge emitted by 1 gram of Ra per second is found to be 33.4 e. s. u., which corresponds to $3.50 \times 10^{10} \times$ particles."

KASSNER, T. Radium in Gordonia. Min. and Ind. Mag. South Africa, vol. 5, No. 11, 1928, p. 437, Johannesburg.

KENTY, C. On the radium content of some Nova Scotian minerals. Nova Scotia Inst. Sci., Proc. and Trans., vol. 16, pts. 1-4, 1927, pp. 174-175, Halifax.

KROLL, FRANZ. The Katanga copper belt. Min. Jour. (London), vol. 162, No. 4847, 1928, pp. 604-605.

Describes mining rights.

MUSHKOVITZEV, S. T. (Newly discovered deposit of radioactive rocks and minerals in the Uzbekistan.) [Russia] Geol. Com. Bull., vol. 46, No. 7, 1928, pp. 701-710, Leningrad. (In Russian, English summary, pp. 709-710.)

NENADKEWICA, K. Sur la composition chimique des uraninites de la Carélie et la relation entre le plomb et l'uranium. (The chemical composition of the uraninite of Karelia and its lead-uranium ratio.) Bull. de l'Acad. des Sci. de l'U. R. S. S., 1926, pp. 767-774.

RAYLEIGH, LORD. Some recent work on the light of the night sky. Nature, vol. 122, 1928, p. 315-317.

The standard comparison light consists in each case of potassium-uranyl sulphate, which is self-luminous, owing to the radioactivity of the contained uranium which stimulates the fluorescence of the salt. There is reason to believe that when in a sealed vessel the source may be regarded as independent of external conditions, and constant, at all events for many years.

The type of photometer chiefly used consists of a Lummer cube, with the field divided into two vertical strips. The right-hand part (transparent) is backed by the uranium salt; the left-hand part (silvered) reflects the sky with a color filter

interposed. Choice from a series of neutral glasses allows the filtered skylight to be matched with the standard.

SCHOEP, ALFRED. La rénardite, nouveau minéral uranifère. Soc. Française Miner. Bull., vol. 51, 1928, pp. 247-252.

SPRECHSAAI. Red uranium glazes and chrome red crystal glazes. Vol. 60, 1927, pp. 871-872. Chem. Abs., vol. 22, March 20, 1928, p. 1022.

"A synopsis of two articles by K. Zimmerman which appeared in the 'Klei' Journal (Holland). U and chrome red glazes are discussed."

STOKLASA, JULIUS, PENKAVA, JOSEPH, FILZ, ZDOBNICKY, SEBOR, STRUPL, and STRADAL. The biology of uranium. Biochem. Ztschr., vol. 194, 1928, pp. 15-76.

TURNER, H. W. Review of the radioactive minerals of Madagascar. Econ. Geol., vol. 23, No. 1, 1928, pp. 62-84, Lancaster.

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ALLGEMEINE ELEKTRICITÄTS-GES. Thermionic valves. British Patent 277997, September 23, 1926. Chem. Abs., vol. 22, July 20, 1928, p. 2498.

"A cathode comprises one or more alkaline earth or other electron-emitting oxides supported by other oxides such as those of Cb, W, Mo, Cr, or U which do not volatilize or dissociate at working temperature. Various details of manufacture are given."

BLOMBERG, A. R., and FREDRIKSSON, P. E. Plastic mass as carrier for radioactive material. Swedish Patent 63704, September 13, 1927. Chem. Abs., vol. 22, March 20, 1928, p. 916.

"A plastic carrier for radioactive material is made by mixing lime soap, mineral oil, resin, Venetian turpentine, and water in such a way and in such proportions that the mass will maintain its plastic consistency without drying or hardening at a temperature of about 37°."

DE CLAIRMONT, A. Apparatus for impregnating water with radium emanations. U. S. Patent 1661604, March 6, 1928.

FISCHER, A. Radioactive material. British Patent 285467, September 22, 1927. Chem. and Ind. (London), vol. 47, October 26, 1928, p. 790.

"Radioactive substances—e. g., radium salts—are introduced into short narrow platinum tubes, sealed at one end, the tube is then fused, welded, or soldered to close it above the substance introduced, and finally the container so produced is heated to bright redness whereby the radioactive metal enters into solid solution in the platinum."

———. Radioactive materials. British Patent 278347, September 29, 1926. Chem. Abs., vol. 22, July 20, 1928, p. 2514.

"Radium or mesothorium or their salts are incorporated with metals or alloys such as Pt or Au which are not easily oxidized and the composite material may be hammered, rolled, or drawn into sheets or wires for use in therapeutic applications or for other purposes. The metal may be preliminarily highly heated and the radioactive material added in the form of a salt together with reducing agents such as glycerol, sugar, or citric acid. Various modifications are described."

FISCHER, R. Radioactive substances and preparations thereof. British Patent 257957, September 6, 1926. Chem. and Ind. (London), vol. 47, October 12, 1928, p. 748.

"A solvent for radioactive emanations is prepared by adding an acid containing an amino group—e. g., 0.1 per cent of diaminohexoic acid hydrochloride—to a suspension of an organic colloid—e. g., gelatin—in an aqueous solution of an alkali or alkaline-earth hydroxide until the solution has P_H 7.4-8.0."

GENERAL ELECTRIC CO. (LTD.) and SMITHELLS, C. J. Filaments for incandescent lamps. British Patent 275735, May 14, 1926. Chem. Abs., vol. 22, July 10, 1928, p. 2332.

"Supports for W filaments are formed of or coated with Cr and U or Mn also may be similarly used although Cr is preferable. These metals are, however, not used adjacent the junction with the filament to avoid alloying of the metal with the W."

LOWY, A. Radium emanation detector. U. S. Patent 1662429, March 13, 1928. Chem. Abs., vol. 22, April 20, 1928, p. 1281.

"A tool ('go devil') adapted to be used within an oil pipe line carries a radioactive substance adapted to activate a detector which serves for indicating the location of the tool when it becomes stuck in the pipe line."

MARDEN, J. W. Rare metal powders. U. S. Patent 1659209, February 14, 1928. Chem. Abs., vol. 22, April 20, 1928, p. 1323.

"An oxide of U or other rare refractory metal is heated with Mg and CaCl_2 or other fluxing agent."

——— X-ray tube. U. S. Patent 1665637, April 10, 1928.

"A cathode may be formed of Mo and the anode is formed of material such as U which has the property of emitting electrons of corresponding value at the same temperature as that to which the cathode may be heated and also possessing better ray-emitting properties than W."

U. S. RADIUM CORPORATION, O. HAHN, assignor. Manufacture of a radium preparation. U. S. Patent 1655184, January 3, 1928. Chem. and Ind. (London), vol. 47, March 30, 1928, p. 231.

"A solution of a lanthanum salt containing a small quantity of a radium salt is treated with hydrofluoric acid to precipitate lanthanum fluoride having radium fluoride dispersed through it. Alternatively, a solution containing radium bromide and thorium nitrate is evaporated to dryness and the residue heated at 500° to give a mixture of radium bromide and thorium oxide. The dispersed radium in such mixtures liberates radon freely."

VANADIUM

UNITED STATES

With the exception of a small shipment from Nevada, the only vanadium ore mined in the United States in 1928 was that produced in Colorado by the United States Vanadium Corporation; the corporation has a mine on East Rifle Creek and an oxide plant on the railroad at Rifle, Colo., 11 miles southwest of the mine. The ore is a fine-grained roscoelite-bearing sandstone in which the roscoelite forms flakes in the interstices, and is probably accompanied by minute particles of other vanadium minerals. The oxide was shipped to Columbiana, Ohio, and Niagara Falls, N. Y., for reduction to ferrovandium. In 1928 the corporation bought the properties of the Standard Chemical Co. in San Miguel Valley, Long Park, and Paradox Valley, and at other places in southwestern Colorado. The claims were formerly worked for radium with vanadium and uranium as by-products. The present owners bought the properties for their vanadium content. The Radium Ores Co.'s plant in Denver was sold for junk.

FOREIGN PRODUCTION

Few details are at hand concerning the production of vanadium in South America or South Africa; the Vanadium Corporation of America, however, continued to hold first position with the production from its Peruvian mines. In 1928 only 1,102,080 pounds of ore, presumably carrying 11 to 12 per cent of vanadium (V), was imported into the United States from Peru, compared with 13,883,520 pounds from that source in 1927.

Europe's needs for vanadium were apparently supplied by the lead-zinc vanadates from South Africa. In 1928, after August 1, 238,938 pounds of ferrovandium, valued at \$215,708, was received in the United States from Germany; it was presumably made from South African ore.

Concerning the production of vanadium in Southwest Africa Sir Edmund Davis, presiding at a meeting of the Southwest Africa Co. (Ltd.), is quoted as saying:⁹

⁹ South African Mining and Engineering Journal, vol. 30, 1928, p. 458.

We have referred in the report to the work at Abenab, which is now fully equipped and the plant working in a satisfactory manner. The total extraction of high-grade vanadium concentrate during the year covered by our accounts was more than double that of the preceding year, which is very satisfactory. Under arrangements which we have now made relating to the regular supply of a fairly big tonnage to large continental buyers we have found it better policy—and they have fallen in with our views—to keep a large stock of concentrates at the buyers' works, so that they may be drawn upon as trade develops, instead of running the risk of delay through having to cable out shipping instructions when sales are effected. Of course, this means locking up additional capital in railage, freight, insurance, and other charges, but this additional temporary outlay is offset by the possibility of making deliveries at a quicker rate when the market in ferrovandium is active and the works require additional supplies. At the general meeting last year I mentioned that trade had not been satisfactory, but that there were signs of a revival which should result in larger sales. I am pleased to be able to say that during the year under review we have been able to increase our sales, and we have now running contracts at prices which, although reduced, will nevertheless leave a fairly satisfactory profit now that our new plant at Abenab is working. Taking the Abenab mine as a separate concern, the profit for the year, after charging liberally for depreciation, amortization, and development redemption, amounted to 21 per cent on the original capital cost of equipping the mine.

USES

The most important new use of vanadium is as a catalyst for making sulphuric acid and various organic compounds. In the manufacture of sulphuric acid certain vanadium salts are said to be fully as efficient as platinum sponge, are not poisoned as is platinum, and are very much cheaper. Catalytic uses, however, will require only small quantities of vanadium and will not noticeably widen the market. In established plants using platinum sponge and burning sulphur instead of sulphides owners claim that the royalty charged on the patented vanadium salts is high enough to pay the interest on the investment in the precious metal and that as the platinum is not poisoned there would be no advantage in changing catalysts. Platinized silica gel is another factor in the situation. By using this material as contact mass a large company that makes acid from pyrites has reduced its platinum requirements by two-thirds.

WORLD PRODUCTION

The world production of vanadium contained in ore or concentrates in 1927 and 1928 was apparently as follows:

World production of vanadium in ores and concentrates, 1927 and 1928

Country	1927		1928	
	Pounds	Value ¹	Pounds	Value ¹
United States.....	(²)	(²)	(²)	(²)
Peru.....	1, 456, 745	\$728, 373	1, 208, 326	\$604, 163
Northern Rhodesia.....	53, 222	26, 611	113, 656	56, 828
Southwest Africa Territory.....	685, 956	342, 978	753, 919	376, 960
Mexico.....	31, 652	826	(⁴)	(⁴)

¹ Value arbitrarily fixed at 50 cents a pound for vanadium contained.

² Bureau of Mines not at liberty to publish figures.

³ Exports.

⁴ Data not available.

IMPORTS

The imports of vanadium ores into the United States over a series of years are shown in the following tables.

Vanadium ore (steel-hardening) imported for consumption in the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919.....	6, 026, 005	\$67, 846	1924.....	14, 116, 596	\$722, 731
1920.....	20, 673, 296	1, 080, 935	1925.....	4, 735, 461	339, 468
1921.....	10, 307, 540	543, 061	1926.....	16, 735, 040	914, 114
1922.....	611, 170	86, 776	1927.....	13, 885, 760	561, 051
1923.....	4, 177, 115	229, 210	1928.....	1, 104, 320	49, 771

Vanadium ore (steel-hardening) imported into the United States, 1927 and 1928, by countries

Country	1927			1928		
	Ore		Value	Ore		Value
	Pounds	Estimated vanadium content (pounds)		Pounds	Estimated vanadium content (pounds)	
Germany.....				2, 240	224	\$159
British South Africa.....	2, 240	224	\$121			
Peru.....	13, 883, 520	1, 631, 313	560, 930	1, 102, 080	129, 494	49, 612
	13, 885, 760	1, 631, 537	561, 051	1, 104, 320	129, 718	49, 771

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- WALKER, G. L. Mining and treating lead-zinc-vanadium ore in Northern Rhodesia. *Eng. and Min. Jour.*, vol. 125, 1928, pp. 733-736.

PATENTS

JOHNSON, J. Y. (Destructive hydrogenation of carbonaceous materials.) British Patent 300703. From I. G. Farbenindustrie Akt.-Ges., Frankfurt-on-Main, Germany. Application date, August 11, 1927. *Chem. Age (London)*, vol. 19, December 22, 1928, p. 589.

"Catalysts for the hydrogenation of coal, tars, mineral oils, distillation, extraction, and conversion products at high temperature and pressure, consist of boron, silicon, titanium, vanadium, tantalum, molybdenum, or tungsten, either free or combined, or cobalt in a combined state, together with not more than 10 per

cent of copper and zinc (or cadmium) either in a free or combined state. The pressure is above 50 atmospheres and the temperature above 400° C."

KOENIG, H. T. Roasting of vanadiferous ores and compounds. U. S. Patent 1654820, January 3, 1928. Chem. and Ind. (London), vol. 47, March 30, 1928, p. 235.

"The ore is heated with sodium chloride and sulphuric acid at 600° to 900° to liberate free vanadic acid."

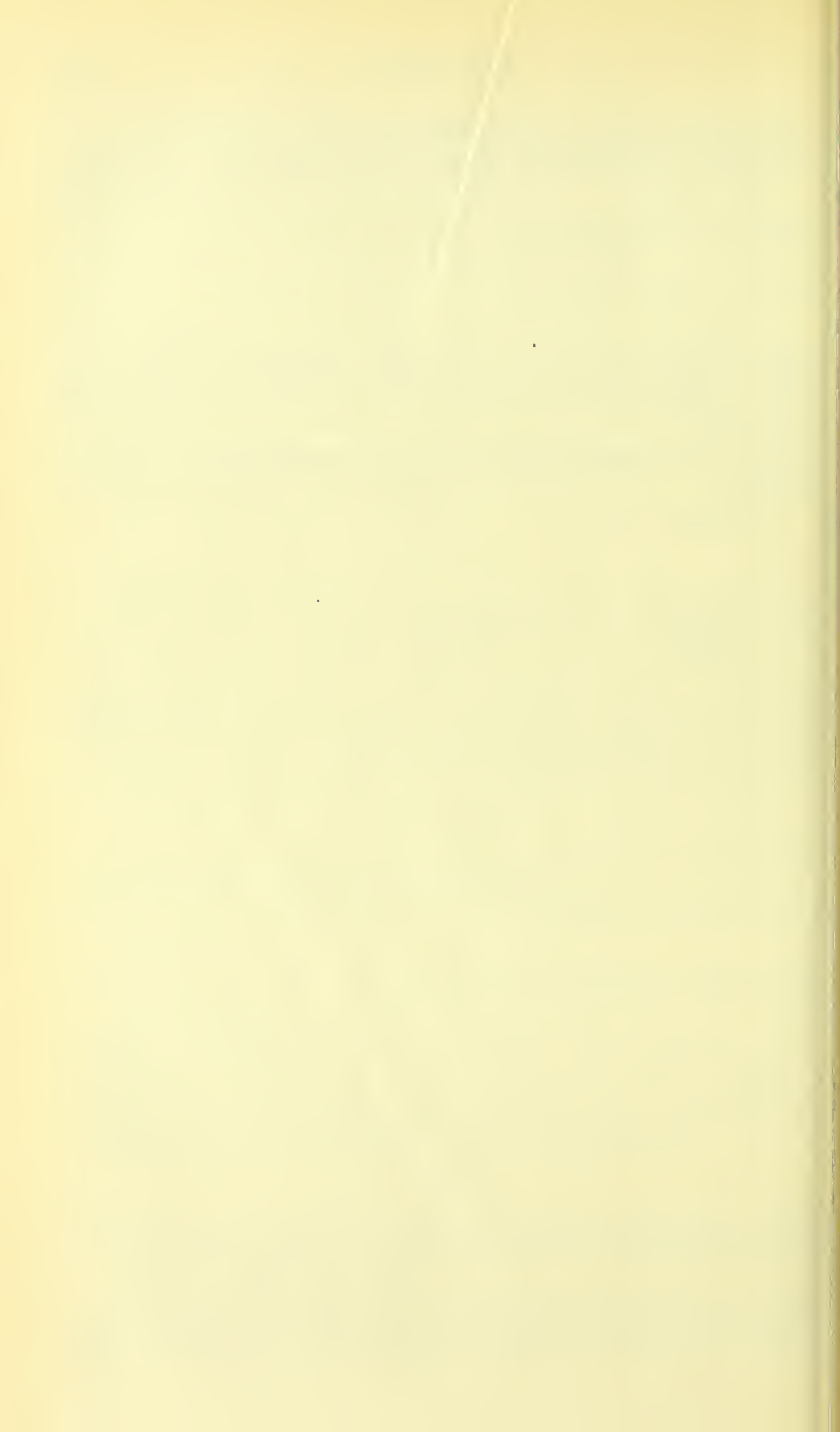
NICKELL, L. F. New vanadium catalyst for sulphuric acid. Chem. and Met. Eng., vol. 35, 1928, p. 153.

STEVENS, R. H., and NORRIS, G. C. Treating zinc-vanadium ores, etc. British Patent 269779, August 23, 1926. Chem. Abs., vol. 22, April 20, 1928, p. 1319.

"V is precipitated from solutions containing free vanadic acid by neutralization, preferably at about 50°, with a base such as ZnO, lime or CaCO₃ in the presence of a ferric compound which may be sufficient for formation of ferric vanadate or some ferric vanadate together with Zn vanadate (if ZnO is used for the precipitation)."

VEAZEY, W. R. Magnesium alloy. U. S. Patent 1663963, March 27, 1927.

V, 0.15 per cent, is used with Mg to give greater strength, hardness, and toughness.



SECONDARY METALS

By J. P. DUNLOP¹

INTRODUCTION

SCOPE OF REPORT

"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, and drosses and are so called to distinguish them from metals derived directly from ores, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality, for metals derived either from ore or from waste material vary in purity and in adaptability to use in making certain products. The figures furnished by producers cover seven metals—secondary copper, zinc, lead, tin, antimony, aluminum, and nickel—and are supplemental to those on the primary metals. They are given to enable producers and consumers to form a more comprehensive idea of the quantities of metal available for consumption; in fact, they constitute an essential addition to the figures given in the general reports on the primary metals and will become more essential in the future.

"Secondary metal" was very aptly defined at the February, 1928, meeting of the American Institute of Mining and Metallurgical Engineers "as that which had lost its original identity as to source."

RECOVERY, TREATMENT, AND USE OF WASTE MATERIAL

The collection of waste material is a long-established branch of industry now vital as a source of supply of many products. It involves the collection, sorting, and shipment of waste having an estimated value of considerably more than a billion dollars yearly. This report covers only about one-fourth of the value and only a small part of the quantity of the waste materials that are marketed. The problems connected with the waste trade are no longer viewed academically by the large consumers of metals and other wastes. They are an important factor in the supply of raw material, and their proper use results in reduced cost of many products. The interest shown in problems connected with metal wastes and their recovery and use continues unabated. Old trade associations are enlarging the scope of their activities, and new ones are being established. Associations to perform service for the lead and aluminum industries, similar to the service rendered by the Copper and Brass Research Association, have been formed. All these associations seek to standardize specifications, to prevent unfair trade practices, to eliminate

¹Figures on imports and exports compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

abuses, and to economize waste, as well as to extend the market for secondary materials.

The Philadelphia Metal Association has a committee that helps small dealers in methods of packing metal wastes and in obtaining shipping accommodations. Imagine this procedure taking place a few years ago. The Institute of Scrap Iron and Steel (Inc.) now includes in its membership all of the large dealers in scrap iron and steel and has established chapters at all of the large ferrous trade centers, including Boston, Buffalo, Chicago, Philadelphia, Pittsburgh, and St. Louis. It is making a survey of every phase of the industry and proposes to eliminate unfair and unprofitable practices and to stimulate cooperative efforts. It recognizes that the business standing of the scrap-ferrous trade in the past was not altogether what it should have been, although never as bad as it was pictured. While the scrap-iron industry has long been a vast one and a vital part of the economic structure of the United States, in recent years its business has not been profitable on the whole. The institute estimates the business of its members at half a billion dollars a year and asserts that more than 30,000,000 tons of iron and steel scrap is being consumed at furnaces, mills, and foundries. It intends to have this large business conducted along modern business lines. At Pittsburgh the institute adopted resolutions condemning abuses that were not uncommon, including defamation of competitors, top dressing of cars, failure to fill orders, overbilling of cars, fictitious bills of lading, etc. Problems of importance, such as agreements as to classification of grades of iron and steel scrap, are to be arranged with consumers. Difficulties connected with the collection and disposal of the various steel alloys are to be investigated. The practice of large consumers of ferrous scrap purchasing directly from small or moderate-size producers of scrap is to be considered. The institute asserts that while direct dealing may be warranted under certain conditions, on the whole the practice will be detrimental to the steel industry. The institute has also authorized the filing of a petition with the Interstate Commerce Commission for the examination and reconstruction of the entire freight schedules on scrap iron and steel.

The Non-Ferrous Ingot Metal Institute, representing about 90 per cent of the production of copper ingot alloys, is now reporting the average prices received by its members for the six principal mixtures sold by them. Recent figures show deliveries averaging more than 10,000 tons a month.

A special committee of the American Society for Testing Materials has been appointed to study, reduce in number, and promote the use of specifications covering copper alloys in ingot form as a basis of price quotations in trade journals. The committee is also authorized to recommend such revision as its studies may indicate to be desirable. Undoubtedly, better organization and closer standard specifications will greatly increase the use of ingot alloys and induce foundries to curtail the purchase and use of primary pig metals and scrap metals. The subject is of vast interest to the metal trades.

A fine exposition of the development of methods and practices in the nonferrous ingot industry, an outline of its functions, and a forecast of its future has been written by G. H. Clamer,² president

²Clamer, G. H., Development and Future of the Nonferrous Ingot Industry: Metal Industry, April, 1929, pp. 178-180.

of the Ajax Metal Co. Study of Clamer's article is recommended to all interested in the metal industries.

The earlier chapters on Secondary Metals in Mineral Resources contain much information regarding the collection of waste material and many references to articles published about smelting and refining nonferrous waste. Various trade papers, such as the Waste Trade Journal, Daily Metal Trade, Brass World, American Metal Market, Foundry, Iron Age, Iron Trade Review, Metal Industry, and Daily Metal Reporter, also contain valuable information relating to prices and marketing of scrap metal and drosses and technical information relating to the proper use of old metals.³

CLASSIFICATION OF OLD METALS

The classification of old metals drawn up by the Metal Division of the National Association of Waste Material Dealers (Inc.) (Times Building, New York, N. Y.) and changed from time to time as desirable is the standard of both dealers and manufacturers in the United States. The latest classification (Circular K), effective March 1, 1928, follows; attention is directed to items 2, 10, and 12, which show changes in the specifications relating to copper wire, heavy yellow brass, and light brass.

STANDARD CLASSIFICATION FOR OLD METALS, EFFECTIVE FROM MARCH 1, 1928

1. *Delivery*.—(a) Delivery of more or less of the specified quantity up to 2½ per cent is permissible.

(b) If the term "about" is used, it is understood that 5 per cent more or less of the quantity may be delivered.

(c) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages an arbitration committee of the National Association of Waste Material Dealers (Inc.), appointed for this purpose, to determine the amount of such damages.

(d) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to an arbitration committee of the National Association of Waste Material Dealers (Inc.), to be appointed for that purpose.

(e) A carload, unless otherwise designated, shall consist of the weight governing the minimum carload weight at the lowest carload rate of freight in the territory in which the seller is located. If destination of material requires a greater carload minimum weight, buyer must so specify.

(f) A ton shall be understood to be 2,000 pounds unless otherwise specified. On material purchased for direct foreign shipment a ton shall be understood to be a gross ton of 2,240 pounds unless otherwise specified.

(g) If, through embargo, a delivery can not be made at the time specified, the contract shall remain valid and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed.

(g-1) When shipments for export for which space has been engaged have been delivered or tendered to a steamship for forwarding and through inadequacy of cargo space the steamship can not accept the shipment, or where steamer is delayed in sailing beyond its scheduled time, shipment on the next steamer from the port of shipment shall be deemed a compliance with the contract as to time of shipment.

(h) In case of a difference in weight and the seller is not willing to accept buyer's weights, a sworn public weigher shall be employed, and the party most in error must pay the costs of handling and reweighing.

³ Metal Industry, Value of a Business Publication: July, 1926, p. 290.

(i) When material is such that it may be sorted by hand, consignees can not reject the entire shipment if the percentage of rejection does not exceed 10 per cent. The disposition of the rejected material should then be arranged by negotiations; no replacement of the rejected material to be made.

Upon request of the shipper, rejections shall be returnable to the seller on domestic shipments within one week and on foreign shipments within 30 days from the time notice of rejection is received by them, and upon payment by them of 1 cent a pound on material rejected to cover cost of sorting and packing; the seller to be responsible for freight both ways.

2. *No. 1 copper wire.*—To consist of clean untinned copper wire not smaller than No. 16 B. & S. Wire gauge to be free from burnt copper wire which is brittle and all foreign substances.

3. *No. 2 copper wire.*—To consist of miscellaneous clean copper wire which may contain a percentage of tinned wire and soldered ends but to be free of hair wire and burnt wire which is brittle; the tinned wire not to be over 15 per cent of the total weight.

4. *No. 1 heavy copper.*—This shall consist of copper not less than $\frac{1}{8}$ inch thick, and may include trolley wire, heavy field wire, heavy armature wire, that is not tangled, and also new untinned and clean copper clippings and punchings, and copper segments that are clean.

5. *Mixed heavy copper.*—May consist of tinned and untinned copper, consisting of copper clippings, clean copper pipe and tubing, copper wire free of hair wire and burnt and brittle wire, free from nickel-plated material.

6. *Light copper.*—May consist of the bottoms of kettles and boilers, bathtub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free from radiators, brass, lead and solder connections, readily removable iron, old electrotypes shells, and free of excessive paint, tar, and scale.

7. *Composition or red brass.*—May consist of red scrap brass, valves, machinery bearings and other parts of machinery, including miscellaneous castings made of copper, tin, zinc and/or lead, no piece to measure more than 12 inches over any one part or to weigh over 60 pounds, to be free of railroad boxes and other similarly excessively leaded material, cocks and faucets, gates, pot pieces, ingots, and burned brass, aluminum composition, manganese, and iron.

8. *Railroad bearing.*—Shall consist of railroad boxes or car journal bearings, must be old standard used scrap, free of yellow boxes, also iron-backed boxes, and must be free of babbitt, also free of excessive grease and dirt.

9. *Cocks and faucets.*—To be mixed red and yellow brass, free of gas cocks and beer faucets.

10. *Heavy yellow brass.*—May consist of heavy brass castings, rolled brass, rod brass ends, chandelier brass, tubing, not to contain over 15 per cent of tinned and/or nickel-plated material; no piece to measure more than 12 inches over any one part and must be in pieces not too large for crucibles. Must be free of manganese mixture, condenser tubes, iron, dirt and excessive corroded tubing. Must be free of aluminum brass containing over 0.20 per cent aluminum.

11. *Yellow brass castings.*—Shall consist of brass castings in crucible shape, that is, no piece to measure more than 12 inches over any one part; must be free of manganese mixtures, tinned and nickel-plated material, and must be free of visible aluminum brass.

12. *Light brass.*—May consist of miscellaneous brass, tinned or nickel plated that is too light for heavy brass, to be free of gun shells containing paper, ashes or iron, loaded lamp bases, clock works, and automobile gaskets. Free of visible iron unless otherwise specified.

13. *Old rolled brass.*—May consist exclusively of old pieces of sheet brass and pipe free from solder, tinned and nickel-plated material, iron, paint, and corrosion, ship sheathing, rod brass, condenser tubes, and Muntz metal material.

14. *New brass clippings.*—Shall consist of the cuttings of new sheet brass to be absolutely clean and free from any foreign substances and not to contain more than 10 per cent of clean brass punchings to be not smaller than $\frac{1}{4}$ inch in diameter.

15. *Brass pipe.*—Shall consist of brass pipe, free of nickel-plated, tinned, soldered, or pipes with cast brass connections. To be sound, clean pipes free of sediment and condenser tubes.

16. *No. 1 red composition turnings.*—To be free of railroad car box turnings and similarly excessively leaded material, aluminum, manganese, and yellow brass turnings; not to contain over 2 per cent free iron; to be free of grindings and foreign material, especially babbitt. Turnings not according to this specification to be sold subject to sample.

17. *No. 1 yellow rod brass turnings*.—Shall consist of strictly rod turnings, free of aluminum, manganese, composition, Tobin and Muntz metal turnings; not to contain over 3 per cent free iron, oil, or other moisture; to be free of grindings and babbitts; to contain not more than 0.30 per cent tin and not more than 0.15 per cent combined iron.

18. *No. 1 yellow brass turnings*.—Shall consist of yellow brass turnings, free of aluminum, manganese, and composition turnings; not to contain over 3 per cent of free iron, oil, or other moisture; to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.

19. *Auto radiators*.—All radiators to be subject to deduction of actual iron. The tonnage specification should cover the gross weight of the radiators.

20. *No. 1 pewter*.—Shall consist of tableware and soda-fountain boxes, but in any case must test 84 per cent tin. Siphon tops to be treated for separately.

21. *Zinc*.—Must consist of clean sheet and cast zinc, also cast batteries to be free of loose oxide and dross, salamoniac cans, and other foreign materials.

22. *Zinc dross*.—Must be unsweated in slabs and must contain a minimum of 92 per cent of zinc.

23. *Tin foil*.—Shall consist of pure foil free of lead compositions and other foreign ingredients and matters.

24. *Electrotype shells*.—Must be hand picked and free of loose dross and chunks of dross.

25. *Scrap lead*.—Should be clean, soft scrap lead.

26. *Battery lead plates*.—Shall consist of dry battery lead plates, moisture not to exceed 1 per cent, allowance to be made for wood, rubber and paper and excess moisture.

27. *New sheet aluminum clippings and new aluminum wire*.—Shall consist of new sheet aluminum, cuttings, and new aluminum wire. Must be free from oil, grease, and any other foreign substances. Must be guaranteed not less than 98 per cent pure aluminum and not to contain more than 10 per cent of clean aluminum punchings to be not smaller than $\frac{1}{4}$ inch in diameter.

28. *Old aluminum wire*.—Shall consist of old aluminum wire guaranteed 98 to 99 per cent pure aluminum and must be free from iron cores, insulation, and any other foreign substance.

29. *Alloy sheet aluminum*.—To be sold on specification and sample.

30. *Painted sheet aluminum*.—Shall consist of painted sheet aluminum and must be absolutely free from iron, dirt, or any other foreign substance.

31. *Old sheet aluminum*.—Shall consist of old and manufactured sheet aluminum. Must be free from painted sheet aluminum, iron, dirt, and any other foreign substance.

32. *Aluminum castings*.—Shall consist of aluminum castings, free from iron, babbitt, brass, and any other foreign substance. Must not exceed 2 per cent of oil and grease. Free of pistons.

33. *Aluminum borings*.—To avoid dispute, should be sold subject to sample.

34. *Aluminum foil*.—Shall consist of pure aluminum foil, free from paper and any foreign ingredients.

35. *Babbitt metal*.—Shall contain bearing metal of all kinds. Shall not contain scrap hard metal, Allen metal (which is copper and lead alloy), die cast, zinc boxes or type metal.

36. *Packages*.—Shall be good, strong packages suitable for shipment, and each package shall be plainly marked with separate shipping marks and numbers and with the gross and tare weights, so that the packages may reach their destination and their weights can be easily checked.

There is a growing demand for scrap-metal specialties (not specifically covered by the preceding classification), such as nickel alloys, German silver, Monel metal, cadmium, and molybdenum. Difficulties in making shipments to buyers' specifications have arisen, and with the object of eliminating some of the trouble the Waste Trade Journal has published certain classifications used by one of its advertisers. It is worth while to reproduce those that follow so that they will be available to sellers of some metals and alloys.

Pure nickel clippings.—To consist of sheeting clippings, guaranteed 99 per cent nickel, to be free of solder material and other alloys. If in a state other than clippings, same is to be mentioned.

Pure nickel turnings.—To consist of nickel turnings free of iron or other foreign material.

No. 1 hard nickel anodes.—To consist of hard anodes with all hooks cut off close to the top of the anodes, to be free of soft, crumbly or heavily corroded anodes.

Nickel dust.—To consist of dry material from nickel anodes, to be free of yellow sulphate and dye-house sludge, or other foreign material.

Nickel platers' basket, hooks, racks, etc.—A good packing shall consist of baskets, hooks, racks, etc., made of either brass or copper, and to have a heavy nickel deposit. Baskets, hooks, racks, etc., made of iron, and which have a heavy nickel deposit to be packed separately. To avoid disputes, all plating baskets, hooks, racks, etc., should be sold subject to sample. Light deposited nickel baskets, hooks, racks, etc., shall not be considered good delivery.

Nickel strippings.—To consist of clean, sieved strippings or peelings, free of brass or copper, and other foreign material, and should not contain strippings that have copper layers in them.

New Monel metal clippings.—To consist of new clippings and skeleton scrap, to be free of brazed and soldered material or other metal attachments.

Monel metal rods, bars, shaftings.—Shall be cut in crucible shape, and to be free of casting or other metal attachments. When not in crucible shape, it should be so stated when asking for quotations.

Old Monel metal.—To consist of old Monel metal sheet scrap, free of solder and brazed material and other foreign attachments. If soldered, it should be so stated when asking for a quotation.

Monel metal screen and wire.—To be free of soldered material and other foreign material. If soldered, it should be so stated when asking for a quotation.

Monel metal turnings.—To consist of Monel metal from rods or turnings, to be free of nickel alloy turnings, other metals and foreign material, and to be sold subject to sample. Turnings from Monel castings to be packed and sold separately.

Monel metal castings.—To consist of castings made from Monel metal only, and in crucible shape, to be free of other nickel alloy composition material, and when not in crucible shape to be so stated when asking for quotations.

Monel metal punchings.—To consist of clean punchings, free of iron or other foreign material.

German silver (nickel silver), sheet clippings, or skeleton scrap.—To consist of clean sheet cuttings or skeleton material, free of other metals or metal attachments and soldered stock. If lots are of a uniform nickel content, the nickel contents should be so stated and guaranteed, otherwise to be sold subject to sample.

German silver turnings.—Shall consist of clean turnings or chips, free of other metals and foreign material, to be sold subject to sample.

Silver-plated ware.—To consist of spoons, forks, and tableware, free of mesh bags, novelty material and compact cases, also free of nickel-plated material and silver flashed stock.

Mercury (quicksilver).—To consist of clean mercury, free of amalgam, zinc dross and tin dross and other foreign material.

Mirror scrapings.—To be sold subject to sample.

Cadmium anodes.—To consist of clean anodes, free of dross, strippings, or other foreign material.

Cadmium strippings.—To be clean stock, free of brass or other foreign material.

Cadmium dross.—To be sold subject to sample.

Bell metal.—Shall consist of large and small bells of a tin-copper composition. It shall be free of yellow brass bells, manganese bells, or other alloy compositions. Cymbals shall be packed separately, and shall not be included in a No. 1 packing of bells.

High-speed tool-steel scrap.—Shall consist of American-made high-speed tool steel with a minimum 15 per cent tungsten contents and shall be free of semi-high-speed tools, high-speed tools with carbon shanks, carbon tool steel or other steel alloyed material.

Molybdenum scrap.—Shall consist of clean, pure molybdenum material in sheet, cast wire or bar stock, and shall be free of nickel or other metal alloys, to be sold subject to sample.

Aluminum foil.—To consist of clean aluminum foil, free of paper, print, pot stack, and other foreign material.

Rifle shells.—Shall consist of clean fired shells, shall be hand-picked and free of any shells containing powder, iron, muffled shells or burnt shells, or any material that is foreign. State caliber when asking for quotations.

Cupro-nickel jackets.—To be free of iron, aluminum, or other foreign material, to be sold subject to sample.

NOTE.—When offering alloy material of special character, furnish complete analysis—state what shape it is in, the quantity available, and send a representative sample.

The National Association of Waste Material Dealers is striving to eliminate difficulties arising in buying and selling metal wastes and appointed a committee to define the terms "metallic yield," "metallic recovery," "metallic button," "metallic contents," "metal," "free metal," etc. The action of the committee is set forth in *Metal Industry* for May, 1929 (pp. 229–230). Briefly summarized, the committee decided that it is to the best interest of the industry to encourage the valuation of secondary metals by chemical analysis and that the use of such terms is unsatisfactory and unwarranted.

Considerable friction exists because of the deduction of excess moisture in battery plates. The specifications provide that the allowable moisture shall not exceed 1 per cent and that allowance shall be made for wood, paper, etc., and excess moisture. Shippers of battery plates invariably think that the smelter's deductions are excessive, especially if their plates have been stored in a dry place for several months. George Birkenstein, of S. Birkenstein & Sons (Inc.), Chicago, makes the following comments:⁴

As a matter of fact, the constitution of a scrap battery lead plate consists of the shell of the original battery grid with the so-called battery mud saturated with sulphuric acid as well as the wooden separator, etc. The fact of the matter is that a lead plate will never dry out unless the sulphuric acid is eliminated. On the contrary they will absorb moisture due to the sulphuric acid contents of the plate.

A simple experiment will prove this to anyone who is doubtful. Take an ordinary glass tumbler, put a few ounces of sulphuric acid in this glass and allow it to stand either in a room or in the open for several days or a week, and, surprising to note, you will find considerably more liquid at the end of that period than you had in the beginning, due to the fact that sulphuric acid has an affinity for water.

With this knowledge it is easy to see how unreasonable and ignorant the dealer is of the true facts concerning the article he is handling the most. The dealer who writes that he has let his plates stand for a period of time and that they are absolutely dry, etc., does not realize that this is an impossibility.

During the winter, and especially this year, plates are running poorer than they have ever run. Frozen plates are coming in car after car, and a frozen plate is probably the most deceiving of all.

An expert will look at a frozen plate and think that he has a dry battery plate before him, but as a matter of fact, by applying a little heat, you will find an abundance of water running from every part of a battery of this kind.

It makes little difference to the smelter that they are plates with mud and lugs chopped off, separators in, and the maximum amount of moisture, providing the proper deduction is made for the inferior material. However, it may compensate the dealer to remove the separators and allow excess moisture to run off as much as possible as he will save possibly from 5 to 10 per cent in freight and deduction.

The day is gradually nearing when the dealer will be as intelligently versed in the material he handles as the consumers, and when this state develops you will find the battery lead business a pleasure—as it should be.

REVIEW OF THE SECONDARY METAL INDUSTRY IN 1928

MARKET CONDITIONS

The total increase in quantity of secondary metals covered in this inquiry was about 9 per cent, compared with an increase of 1 per cent in 1927. There were small decreases in the output of tin and

⁴ Birkenstein, George, Why There is Excess Moisture in Battery Plate Scrap—How It Can Be Cut Down: *Waste Trade Jour.*, Feb. 16, 1929, p. 3

antimony, and large gains in the output of copper, brass, lead, and nickel. The higher average price of copper and the larger output of secondary copper and brass were mainly responsible for the increase in 1928 of \$18,259,300 in total value. Average prices for lead, zinc, antimony, and aluminum were lower in 1928 than in 1927. The price of nickel was stable, and the recoveries from secondary sources increased about 1,000 tons. The higher price for primary copper stimulated the export of copper and brass scrap from the eastern coast to Europe, and the combined exports in 1928 exceeded those in 1927. At times agents for European consumers paid higher prices for scrap than domestic smelters offered, and a temporary scarcity of supplies resulted.

While there remains much need for improvement in the waste-material industry, the efforts of the various trade associations have been distinctly beneficial and have tended to adjust the industry to more modern conditions with greater profit and better cooperation. Although the profits in 1928 were not excessive, and in many branches not even satisfactory, on the whole dealers in and smelters of waste metals and drosses made more money than in any other of the last five years, largely because of the advance in the general standard of integrity. Consumption was good, copper prices tended slightly upward, and some accumulated stocks were marketed. Prices for nearly all metals were fairly stable, and there was little opportunity for large speculative profits; consequently waste metals were purchased and treated at costs that would enable their sale at a normal profit. The waste-trade industry continued to concentrate in larger units; this concentration tended more and more to stabilize prices and grades of products and to encourage the more general use of secondary materials. The higher price of common labor has resulted in a decrease in rural collection of wastes, notwithstanding the increased distribution of metal household products, and the larger recovery of secondary metals apparently is due solely to larger collections at centers of industry. Only the scrap and waste material that can meet the cost of collecting, packing, loading, freight, and treatment can be made available for consumption. Under present economic conditions only a small percentage of the waste paper, rags, and metals discarded at homes now returns to the waste trade. The United States is undoubtedly the most efficient nation in the world in many respects, but its efficiency and prosperity have made its individuals generally indifferent and callous to small savings.

PRICES OF SOME SCRAP METALS AND ALLOYS

The tables that follow show certain scrap-metal prices at New York in 1928 as quoted by the Waste Trade Journal and the American Metal Market.

The dealers' weekly average buying price in New York of No. 1 heavy scrap copper ranged from 12 to 12.25 cents a pound during January, February, March, and April. In the third week in May it increased to 12.40 cents, and at the end of May it was 12.65 cents. The June quotations were 12.75 to 12.90 cents. The market weakened to 12.50 cents in July and was stable at that price until the middle of August. In September the price advanced steadily from 12.70 cents at the beginning to 13.15 cents at the end of the month. The October opening price was 13.35 cents and advanced to 13.50 cents

at the close of the month. The quotations in November ranged from 13.90 to 14 cents. Early in December the price was 14 cents, followed by a decline to 13.90 cents for two weeks, and then an advance to 14.35 cents. The highest quotation was 14.35 cents in December and the lowest was 12 cents in February, a spread of 2.35 cents as compared with a spread of 1.60 cents in 1927.

No. 1 composition scrap (red brass) showed a range of 1.85 cents a pound in 1928 compared with a range of 1 cent in 1927. It was quoted at 9.75 cents a pound in January, was lowest at 9.50 cents in May, was highest at 11.35 cents in December, and closed the year at that quotation.

The price of heavy scrap lead began the year at 5.40 cents a pound; at the end of February it was 4.90 cents; the first week in March it reached the lowest quotation of the year, 4.75 cents; after which it advanced again to 4.90 cents and remained at that price during the rest of the month. Prices were steady at 5.15 cents in April and May, advanced to 5.40 cents early in June, then slumped to 5 cents in July. The August prices were 5.10 to 5.15 cents, and those for September were 5.25 to 5.40 cents. About the middle of October the quoted price declined to 5.30 cents, the closing price of November was 5.15 cents, and the year closed with a slight advance to 5.25 cents in December.

The range in the price of scrap zinc in 1928 was half a cent a pound compared with 1 cent a pound in 1927. The price was 3.65 cents early in January and as low as 3.15 cents in March. After opening at 3.65 cents in January the price declined to 3.40 cents at the end of the month. This price held in February and early March. In the second week of March the quotation slumped to 3.15 cents, but in the next week it advanced again to 3.25 cents and in the last two weeks to 3.40 cents. The price then held at 3.40 cents for eight months, or to the first week in December when there was a break to 3.25 cents followed by an advance to 3.50 cents, which price prevailed until the end of the year.

There was a much smaller range in the quoted prices of cast aluminum in 1928 than in 1927, when the prices ranged from 11.50 cents a pound to 15.25 cents. In 1928 the range was from 11.50 cents to 12.25 cents. The highest prices were in February, March, April, May, June, and December, and the lowest in January, February, July, August, and September. The year closed with the price at 12.25 cents. New aluminum clippings ranged in price from a high of 17.75 cents a pound during the first quarter of 1928 to a low of 16.87 cents in the last quarter of the year. The spring quotations were 17.75 cents a pound; thereafter they decreased steadily, although the decreases were not abrupt or large.

The price of secondary tin usually follows the trend of prices for primary 99 per cent tin, which had a range of 12.37 cents during 1928. Block-tin pipe was quoted as high as 48.38 cents a pound in January and as low as 38.98 cents in July. Of the nonferrous metals tin and alloys containing tin showed the widest range in prices, with declining quotations during the first seven months and small steadily increasing quotations for the remainder of 1928.

Owing to the lower prices of lead the quotations on antimonial lead battery plates were less than in 1927. The consumption is estimated by dealers to be about 10,000 tons per month. The plates are generally sold at prices ranging from 55 to 65 per cent of the prevailing price of pig lead.

Scrap nickel and nickel alloys were in steady demand, and as the price of primary nickel was stable throughout the year, the price of metal scrap fluctuated little.

Average scrap-metal prices in 1928, in cents per pound¹

[New York dealers' weekly average buying prices]

Date	No. 1 heavy copper	No. 1 composition	Heavy lead	Scrap zinc	Cast aluminum	Date	No. 1 heavy copper	No. 1 composition	Heavy lead	Scrap zinc	Cast aluminum
Jan. 7	12.25	9.75	5.40	3.65	11.50	July 7	12.50	9.75	5.15	3.40	11.75
14	12.15	9.75	5.25	3.50	11.50	14	12.50	9.75	5.00	3.40	11.75
21	12.15	9.75	5.25	3.40	11.50	21	12.50	9.75	5.00	3.40	11.25
28	12.15	9.75	5.25	3.40	11.50	28	12.50	9.75	5.15	3.40	11.50
Feb. 4	12.15	9.75	5.15	3.40	11.50	Aug. 4	12.50	9.75	5.10	3.40	11.50
11	12.15	9.75	5.15	3.40	12.00	11	12.50	9.70	5.10	3.40	11.50
18	12.15	9.75	5.10	3.40	12.25	18	12.60	9.70	5.10	3.40	11.50
25	12.00	9.70	4.90	3.40	12.25	25	12.50	9.70	5.15	3.40	11.50
Mar. 3	12.15	9.70	4.75	3.40	12.25	Sept. 1	12.70	9.75	5.25	3.40	11.50
10	12.15	9.70	4.90	3.15	12.25	8	12.90	9.75	5.25	3.40	11.50
17	12.15	9.70	4.90	3.25	12.25	15	12.90	9.75	5.25	3.40	11.50
24	12.15	9.70	4.90	3.40	12.25	22	13.00	10.00	5.40	3.40	11.50
31	12.25	9.70	4.90	3.40	12.25	29	13.15	10.15	5.40	3.40	11.75
Apr. 7	12.25	9.75	5.15	3.40	12.25	Oct. 6	13.35	10.25	5.40	3.40	11.75
14	12.25	9.75	5.15	3.40	12.25	13	13.35	10.25	5.30	3.40	11.75
21	12.25	9.75	5.15	3.40	12.25	20	13.35	10.15	5.30	3.40	11.75
28	12.25	9.70	5.15	3.40	11.95	27	13.50	10.50	5.30	3.40	11.75
May 5	12.25	9.50	5.15	3.40	12.00	Nov. 3	14.00	10.65	5.30	3.40	12.00
12	12.25	9.50	5.15	3.40	12.00	10	13.90	10.75	5.30	3.40	12.00
19	12.40	9.90	5.15	3.40	12.00	17	13.90	10.75	5.15	3.40	12.00
26	12.65	10.00	5.15	3.40	12.25	24	13.90	10.75	5.15	3.40	12.00
June 2	12.75	10.00	5.40	3.40	12.25	Dec. 1	14.00	10.75	5.15	3.25	12.00
9	12.75	10.00	5.40	3.40	12.25	8	14.00	10.75	5.30	3.25	12.00
16	12.90	10.00	5.25	3.40	12.00	15	13.90	10.75	5.25	3.25	12.00
23	12.75	9.90	5.15	3.40	11.75	22	13.90	10.85	5.25	3.50	12.00
30	12.75	9.90	5.15	3.40	11.75	29	14.35	11.35	5.25	3.50	12.25

¹ Waste Trade Journal, New York, Jan. 26, 1929.

The following monthly average prices at New York in 1928 for new scrap-zinc clippings, old zinc, block-tin pipe, and new aluminum clippings, in cents per pound, were quoted by the American Metal Market.

Average scrap-metal prices at New York in 1928, in cents per pound¹

Month	New scrap-zinc clippings	Old zinc	Block-tin pipe	New aluminum clippings	Month	New scrap-zinc clippings	Old zinc	Block-tin pipe	New aluminum clippings
January	4.37	3.62	48.38	17.75	August	4.09	3.25	39.50	17.05
February	4.30	3.55	45.47	17.75	September	4.25	3.25	39.71	16.87
March	3.87	3.12	44.36	17.75	October	4.25	3.25	40.00	16.87
April	3.87	3.12	44.50	17.60	November	4.29	3.26	40.17	16.87
May	3.87	3.19	44.50	17.37	December	4.62	3.37	41.75	16.87
June	3.87	3.25	41.36	17.37	Year	4.13	3.29	42.39	17.29
July	3.87	3.25	38.98	17.37					

¹ Metal Statistics, 1929.

SECONDARY METALS RECOVERED

The quantity of the metals contained in numerous alloys made partly or wholly from secondary material can not be ascertained definitely. The figures given as the result of the annual canvass are only approximate, but they constitute the sole available data on an important industry.

The increase in the value of the secondary metals, exclusive of gold, silver, platinum, iron, steel, and ferro-alloys, recovered in the United

States in 1928 was due mainly to the higher average price of copper and the greater quantity of copper and copper alloys recovered.

The quantity of secondary platinum metals recovered in the United States in 1928 was 55,831 troy ounces, 2,759 ounces more than in 1927, and equaled 41 per cent of the platinum metals imported for consumption in 1928.

The value of the gold and silver contained in old jewelry, dental waste, tableware, ornaments, and other articles remelted or refined in 1928 was \$28,179,834. Mints and refineries reported the recovery of 9,461,295 fine ounces of silver and \$22,643,976 in gold from waste or discarded material. Jewelry and dental waste furnished the largest supplies of secondary gold and silverware and photographic waste the largest amount of secondary silver.⁵ The consumption of silver in the arts and industries in the United States in 1928 is estimated at 35,547,663 ounces. Most of the silver recovered from photographic waste is obtained from solutions and is recovered by the larger makers of films and plates and by the motion-picture industry.⁶ Generally these solutions contain less than half an ounce of silver to the gallon. The recovery from waste film is probably 800 ounces to the million feet.⁷ Plants in Denver, Los Angeles, and San Francisco recovered large quantities of silver from waste films.

In 1927 and in 1928 about 15,000 pounds of mercury was obtained in Nevada from old dumps and slimes at mills which formerly treated gold and silver ores by amalgamation. No data are collected by the Bureau of Mines showing the quantity of secondary ferrous materials collected and sold for remelting, nor are figures available showing the quantity and value of old rails, pipe, machinery, and other equipment renovated and sold for original use. The collection and reuse of such material is extensive, and the sales involve millions of dollars. The extended use of various ferrous alloys makes the problem of their disposal a difficult one for the collectors.

Secondary metals of certain classes recovered in the United States, 1927-28

	1927		1928	
	Short tons	Value	Short tons	Value
Copper, including that in alloys other than brass.....	290,000	\$75,980,000	325,000	\$93,600,000
Brass scrap remelted.....	286,000	60,516,400	302,000	70,935,200
Lead as metal.....	119,000		138,000	
Lead in alloys.....	157,000	34,776,000	170,600	35,797,600
Zinc as metal.....	64,800		70,700	
Zinc in alloys other than brass.....	12,400	9,881,600	12,500	10,150,400
Zinc as metal.....	8,800		8,200	
Zinc in alloys and chemical compounds.....	28,100	46,302,100	27,600	35,678,300
Antimony as metal.....	1,700		745	
Antimony in alloys.....	10,700	3,060,300	11,155	2,451,400
Aluminum as metal.....	23,000		24,500	
Aluminum in alloys.....	23,200	23,469,600	23,300	22,848,400
Nickel as metal.....	480		635	
Nickel in nonferrous alloys and salts.....	2,900	2,366,000	3,865	3,150,000
	-----	256,352,000	-----	274,611,300

⁵ Hoke, C. M., *Methods of Handling Gold and Platinum Wastes: Metal Industry*, June, 1927, pp. 240-42, and September, 1927, pp. 371-372.

⁶ Weisburg, Louis, *Recovery of Silver from Solutions Used in Photographic Work: U. S. Patent 1527942*, Feb. 24, 1925.

⁷ Byers, C. A., *Recovery of Silver from Movies' Laboratory Waste: Eng. and Min. Jour.-Press*, Aug. 3, 1922, p. 373.

Secondary metals of certain classes recovered in the United States, 1919-1928, in short tons

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Copper, including that in alloys other than brass.....	112, 400	130, 600	113, 350	144, 100	193, 200	193, 500	250, 600	281, 700	290, 000	325, 000
Brass scrap remelted.....	249, 700	259, 800	148, 500	274, 000	311, 000	274, 000	242, 300	283, 000	286, 000	302, 000
Lead as metal.....	55, 684	56, 350	46, 370	75, 480	96, 430	90, 400	112, 420	125, 000	119, 000	138, 000
Lead in alloys.....	66, 416	68, 300	57, 410	84, 080	98, 060	114, 100	114, 460	152, 300	157, 000	170, 600
Zinc as metal.....	39, 910	42, 850	33, 833	69, 314	65, 210	58, 886	61, 430	64, 570	64, 800	70, 700
Zinc in alloys other than brass.....	6, 062	7, 650	5, 840	10, 250	8, 630	10, 500	13, 300	13, 430	12, 400	12, 500
Tin as metal.....	5, 977	7, 200	5, 000	6, 570	7, 892	7, 700	7, 950	9, 730	8, 800	8, 200
Tin in alloys and chemical compounds.....	18, 056	16, 300	11, 500	12, 940	27, 318	23, 000	23, 000	23, 630	28, 100	27, 600
Antimony as metal.....	48	200	29	182	245	90	1	2, 910	1, 700	745
Antimony in alloys.....	4, 351	5, 400	4, 091	6, 908	7, 776	9, 314	10, 839	13, 320	10, 700	11, 155
Aluminum as metal.....	6, 017	5, 000	3, 650	7, 190	6, 800	10, 350	17, 700	20, 500	23, 000	24, 500
Aluminum in alloys.....	12, 674	10, 500	5, 250	9, 100	14, 500	16, 650	26, 300	23, 700	23, 200	23, 300
Nickel as metal.....	163	270	86	104	177	114	191	485	480	635
Nickel in nonferrous alloys and salts.....	2, 284	1, 930	859	1, 408	1, 373	2, 126	2, 109	2, 565	2, 900	3, 865
Total quantity.....	579, 742	612, 350	436, 768	701, 626	833, 611	814, 330	882, 600	1, 016, 880	1, 028, 080	1, 118, 800
Total value.....	\$181, 841, 500	\$188, 507, 260	\$89, 140, 500	\$143, 891, 700	\$205, 418, 600	\$200, 578, 600	\$243, 570, 700	\$274, 540, 900	\$256, 352, 000	\$274, 611, 300

SECONDARY COPPER

Secondary copper recovered in the United States, 1927-28, and imports and exports of brass and copper scrap, in short tons

	1927	1928
Copper as metal.....	201,000	230,000
Copper in alloys other than brass.....	89,000	95,000
	290,000	325,000
Copper from new scrap (not including brass).....	57,000	68,000
Copper from old scrap (not including brass).....	233,000	257,000
	290,000	325,000
Brass scrap remelted:		
New clean scrap.....	134,000	147,000
Old scrap.....	152,000	155,000
	286,000	302,000
Copper content of brass scrap (averaging 70 per cent copper):		
New scrap.....	93,800	102,900
Old scrap.....	106,400	108,500
	200,200	211,400
Total secondary copper (including copper content of brass scrap):		
From new scrap.....	150,800	170,900
From old scrap.....	339,400	365,500
	490,200	536,400
Brass scrap imported.....	3,993	6,077
Scrap copper imported.....	3,739	5,304
Brass ("ingots, scrap, and old") exported.....	45,997	42,413
Scrap copper exported.....	22,709	27,733

The plants refining mainly primary metal recovered 116,323 short tons of the total secondary copper recovered in 1928, or about 11,400 tons more than they reported for 1927. The copper produced by smelters of secondary material included 113,700 tons of pig copper, 95,000 tons of copper in alloys other than brass, and 211,400 tons of copper in remelted brass. These figures indicate increases of 17,100 tons of pig copper, 6,000 tons in alloys other than brass, and 11,200 tons in remelted brass. The total value of the secondary copper, as metal and in alloys, computed at 14.4 cents a pound—the average price for the year of all marketable grades of new metal—amounted to \$154,483,200.

The imports of scrap copper increased from 3,739 short tons in 1927 to 5,304 tons in 1928, and the imports of scrap brass from 3,993 short tons in 1927 to 6,077 tons in 1928; most of this copper and brass scrap came from Canada and Latin America. One significant feature of the copper market in 1928 was the continuation of the large exports of scrap copper and brass from the United States to Europe (mainly Germany). Representatives of foreign dealers and smelters shipped 27,733 tons of scrap copper and 42,413 tons of scrap brass. This scrap was purchased mainly in eastern territory and was shipped from New York, Baltimore, and Philadelphia.

Railways produce large quantities of both ferrous and nonferrous scrap, most of which they sell to dealers or turn in as part payment for new metal. Reports in 1928 show that the railways did not reuse in 1928 at their own shops or plants as much scrap metal, such as babbitt, solder, and bronze, as in 1927. They undoubtedly turned over

the bulk of their metal waste to dealers and smelters and purchased ingot or pig metal. They utilized the following scrap metals in 1928: 1,100 tons of copper; 1,800 tons of brass; 21,000 tons of copper contained in alloys other than brass; 2,184 tons of tin in babbitt, solder, and bronze; and 1,750 tons of lead in various alloys. Only a very small part of the immense quantity of burned-out electric lamps is salvaged, yet the bins of junk dealers and secondary-metal plants often contain boxes of the brass lamp shells. The New York Edison Co. has perfected a new machine, termed a "rumbler," to treat them. Metal Industry gives a description⁸ of this machine, as follows:

Every year the company collects about 300,000 of these incandescent lamps from its offices, stations, and other places. Only the brass shells at the end, the part that screws into the socket, are worth saving, being sold as scrap metal.

The old method of reclaiming this metal was to break the lamps by hand. They were put into a barrel, rigged like a churn, and a dasher worked up and down. Breaking the lamps in this way not only was slow and costly but too much material adhered to the brass shells, lowering their market value.

The new motor-driven rumbler is a long, round machine. A revolving steel cylinder inside is perforated with many holes that are not quite large enough for the brass shells to fall through. About a barrelful of the glass bulbs, 300 to 500 of all sizes, is poured into the cylinder. Loosely placed among them are two long steel bars, which are covered with prongs.

As the rumbler revolves at high speed, these prongs quickly knock—well, they knock glass, filament, wires and even cement loose from the brass shells with many crashing and popping noises. The débris falls through the holes in the cylinder into a steel drawer and the brass shells, clean and bright, remain inside the cylinder.

Some idea of the extent of the recovery of waste metals at foundries, rolling mills, etc., is given in an article by F. A. Westbrook.⁹

Another article of interest has been written by E. S. Tomkins,¹⁰ mining and metallurgical engineer.

SECONDARY LEAD

Secondary lead recovered in the United States, 1927-28, in short tons

	1927	1928
Secondary lead recovered by smelters that treat mainly ore.....	38,424	55,930
Secondary lead recovered by smelters that treat only scrap and drosses.....	80,576	82,070
	<u>119,000</u>	<u>138,000</u>
Secondary lead recovered in remelted alloys:		
Lead content of antimonial lead scrap treated at regular lead smelters.....	8,553	11,063
Lead content of drosses and scrap alloys treated at secondary smelters.....	148,447	159,537
	<u>157,000</u>	<u>170,600</u>
Total secondary lead recovered.....	<u>276,000</u>	<u>308,600</u>

Refined primary lead produced in the United States, 1927-28, in short tons

	1927	1928
From domestic ore.....	668,320	626,202
From foreign ore and base bullion.....	128,210	154,869
Lead content of antimonial lead from foreign and domestic ores and bullion treated at regular smelters.....	<u>21,611</u>	<u>29,626</u>

⁸ Metal Industry, May, 1929, p. 227.

⁹ Westbrook, F. A., New Rolling Mill Waste Recovery Plant: Metal Industry, January, 1929, pp. 1-3.

¹⁰ Tomkins, E. S., Secondary Metal Reclaiming: Metal Industry, January, 1929, pp. 14-15.

The output of secondary lead in 1928 was equal to 39.5 per cent of the total refined primary lead produced in the United States and was more than 115,800 tons greater than the output of primary lead from ores mined in Missouri, the largest lead-producing State. The quantity of secondary lead recovered in 1928 was 32,600 tons more than in 1927; that recovered as pig lead was 19,000 tons more, of which those smelters whose product is mainly primary metal reported an increase of more than 17,500 tons. The quantity of lead recovered in alloys increased 13,600 tons. The regular smelters of primary metal reported an increase of about 2,500 tons in the lead content of antimonial lead scrap treated by them.

The main sources of supply of secondary lead are battery plates, lead cable, lead pipe, and lead lining of acid tanks, but large quantities are also derived from babbitt, solder, type metal, terne metal, brass, and white metal drosses. There does not appear to have been much increase in the total quantity of old battery plates treated. There probably was some increase in automobile battery plates, but a decrease in others. There was complaint that too much was frequently paid for old battery plates and that profits were below normal.

SECONDARY ZINC

Secondary zinc¹ recovered in the United States, 1927-28, and products made from zinc dross, skimmings, and ashes, in short tons

	1927	1928
Secondary zinc recovered by redistillation.....	42,784	48,666
Secondary zinc recovered by sweating, remelting, etc.....	22,016	22,034
Total zinc recovered unalloyed.....	64,800	70,700
Zinc recovered in alloys other than brass.....	12,400	12,500
Zinc recovered in brass (estimated).....	53,200	66,000
Zinc dust made from zinc dross.....	4,850	6,208
Zinc dross used for zinc dust (estimated).....	5,700	7,200
Zinc concentrates and ore exported.....	46,716	4,518
Zinc dross exported.....	4,451	3,148
Lithopone made from zinc skimmings and ashes.....	54,214	61,665
Secondary zinc content of lithopone.....	10,873	12,186
Zinc chloride made from zinc skimmings, ashes, etc.....	40,107	44,057
Zinc content of zinc chloride made from zinc skimmings, etc.....	8,824	9,692
Zinc content of zinc sulphate made from zinc skimmings, ashes, etc.....	720	771

¹ Figures do not include scrap and dross used for lithopone, oxide, zinc dust, or chloride. The use for some of these, especially for zinc chloride, is quite large.

Secondary zinc recovered as pig metal and in alloys (including brass) showed an increase of 8,800 tons in 1928. This increase was mainly in redistilled zinc from drosses, etc., which increased 5,882 tons. The quantity of zinc in brass (66,000 tons) and in alloys other than brass (12,500 tons) increased only 2,900 tons.

The total recovery of secondary zinc (including that in brass) in 1928 was equal to 25 per cent of the total output of primary zinc in the United States.

The quantity of zinc recovered by redistillation increased from 42,784 tons in 1927 to 48,666 tons in 1928. Of the 1928 total 21,242 tons was recovered at retort smelters that treat mainly ore, an increase of only 500 tons, and 27,424 tons, an increase of nearly 5,400

tons, was recovered by redistillation of zinc drosses at six plants that use large graphite retorts of 600 to 800 pounds capacity instead of small clay retorts such as are used by smelters treating zinc concentrates or mixed concentrates and drosses. The six zinc smelters that used the large retorts in 1928 were as follows:

Birmingham Smelting & Refining Co., Birmingham, Ala.
Federated Metals Corporation, Trenton, N. J.
General Smelting Co., Philadelphia, Pa.
Superior Zinc Corporation, Philadelphia, Pa.
Tottenville Copper Co., Tottenville, N. Y.
Wheeling Steel Corporation, Wheeling, W. Va.

Of the secondary zinc recovered unalloyed 69 per cent was obtained by redistillation and the remainder by sweating and remelting. The latter processes do not yield all the metal content so that the residues are sold to secondary smelters for redistillation or are sold to makers of chemical compounds. Nearly all the zinc chloride is made from zinc skimmings and other residues; much of the zinc sulphate, zinc dust, and lithopone is also made from such materials, so that there is normally an active market for zinc drosses, skimmings, and ashes. A description of modern practice in producing good zinc from scrap and other wastes, prepared by E. R. Thews, is given in *Metal Industry*, February, 1927 (pp. 600-602), and March, 1927 (pp. 107-108).

A number of plants, including two in San Francisco, that normally are large exporters, make zinc dust from zinc drosses, so that galvanizers on the coast have a good market for their drosses. It is estimated that 7,200 tons of dross was used in 1928 to make 6,208 tons of zinc dust, which was about 26 per cent more than in 1927. Of a total output of 190,879 tons of lithopone (a zinc pigment containing approximately 20 per cent of zinc) 61,665 tons, containing 12,186 tons of zinc, was made from zinc skimmings and ashes, or 7,451 tons more than the quantity of lithopone made from zinc residues in 1927.

The quantity of zinc chloride made in 1928 was 44,075 tons (an increase of nearly 4,000 tons), of which 44,057 tons, containing 9,692 tons of zinc, was made from zinc skimmings, ashes, galvanized clippings, etc. Zinc sulphate containing 771 tons of zinc was made from skimmings and a small quantity of galvanized clippings.

The exports of zinc dross decreased from 4,451 tons in 1927 to 3,148 tons in 1928, which is only about one-third of the exports in 1926.

The American Bureau of Metal Statistics estimates that 291,000 tons of zinc (11,000 tons more than in 1927) was used in 1928 for zincking (galvanizing) sheets, forms, tubes, wire, etc. Some zinc chloride was made from scrap and zincked steel clippings, but the quantity treated probably did not exceed 2,000 tons, so that the recovery of zinc from that source was very small compared with the consumption of zinc for coating purposes.

Metal Industry reports that zinc from coated clippings (if the coating is heavy) can be recovered by placing the clippings in a molten zinc bath which melts most of the coating. Another method is to distil off the zinc and catch the fume in a cloth bag in a cooling chamber.

Many people are familiar with the practice of weighting certain silk products with tin chloride, but few know that zinc oxide is sometimes used by textile manufacturers in preparing cotton goods; a considerable quantity of zinc residues from this source is received at zinc smelters every year.

SECONDARY TIN

Secondary tin recovered in the United States, 1927-28

	1927	1928
Tin recovered as pig tin.....short tons..	8,800	8,200
Tin recovered in alloys and chemical compounds.....do.....	28,100	27,600
Clean tin-plate scrap treated at detinning plants.....long tons..	36,900	35,800
Old tin-coated containers treated.....do.....	198,600	204,200
	12,824	500
Metallic tin recovered at detinning plants.....pounds..	2,288,000	1,754,549
Tin content of tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants.....pounds..	4,462,000	4,433,751
Total tin recovered at detinning plants.....do.....	6,750,000	6,188,300
Tin tetrachloride, tin bichloride, tin crystals, and tin oxide made at detinning plants.....pounds..	9,882,000	9,183,943
Average quantity of tin recovered per long ton of old tin-coated containers.....pounds..	16.24	4.0
Average quantity of tin recovered per long ton of clean tin-plate scrap.....do.....	32.9	30.3

Tin (metal) and tin concentrates (tin content) imported into the United States, 1927-28, in short tons

	1927	1928
Tin imported as metal.....	79,679	87,327
Tin concentrates (tin content) imported.....	137	146

The United States in 1928 consumed tin in amount equivalent to more than 50 per cent of the world's output of primary tin in 1928, but the domestic production was only 68 tons of tin concentrates, mainly from Alaska and South Dakota, containing 46 short tons of tin. The secondary tin recovered in the United States in 1928 was equal to 41 per cent of the tin imported into the United States as pig metal in 1928 (87,327 short tons). The recovery of secondary tin decreased from 36,900 short tons, valued at \$46,302,100, in 1927 to 35,800 tons, valued at \$35,678,300, in 1928. The total value assigned is based on the yearly average price (49.83 cents a pound in 1928) given by the American Metal Market for 99 per cent metal, prompt delivery at New York, a price which was almost 13 cents a pound less than the average price in 1927.

The quantity of secondary pig tin recovered decreased 600 tons. The largest recoveries of tin as tin are made from scruff and drosses that occur in making tin plate; these recoveries increased from 6,500 tons in 1927 to 6,800 tons in 1928. The quantity of tin plate andterneplate made in 1928 (according to the American Iron and Steel Institute) was 1,839,000 long tons, or 150,800 long tons more than in 1927. The quantity of tin estimated to have been used for such products is 26,572 long tons.

The quantity of tin recovered in alloys and chemical compounds in 1928 decreased 500 tons. Most of this decrease was due to the much lower recovery from tin-plate clippings and old containers. The recovery of tin from tin-plate clippings has declined from 36.49 pounds per ton in 1924 to 30.3 pounds in 1928. Some tin was also recovered from waste tin liquors used in dyeing.

Nearly all detinning in the United States is done by the electrolytic process or by the chlorine process. Many of the earlier chapters of this series contain data relating to the plants and processes followed, and a complete history of the different methods of detinning is given in an article entitled "Scrap Detinning Affords Big Outlet for Chlorine," by C. L. Mantell, in *Chemical and Metallurgical Engineering*, August, 1926 (pp. 477-479).

Reports received show that the clean tin-plate scrap detinned in 1928 was 5,600 long tons more than in 1927. The average tin content of the tin oxide made by detinners was given as 78 per cent, that of the tin bichloride as 24.5 per cent, and that of the tin tetrachloride as 45.4 per cent. The average cost of tin-plate clippings detinned at the plants in 1928 was \$11.65 a long ton and the average recovery of tin per long ton of clean tin-plate scrap was 30.3 pounds, a decrease of 2.6 pounds from the average recovery in 1927.

It is estimated that the tin-plate makers have reduced the amount of tin consumed per ton of tin plate made from 39 pounds in 1923 to 36 pounds in 1928. At the same time the quality of the tin plate has been improved largely by a more uniform and better distribution of the tin coating accomplished by a more accurate rolling of the black plate and improved trimming methods. The list edge formerly involving a large loss has been almost eliminated, and this procedure decreased materially the salvage that could be recovered by detinning plants to which the scrap was sold.

New tin-plate clippings were treated at plants of the Vulcan Detinning Co. at Sewaren, N. J., Neville Island, Pa., and Streator, Ill.; by the Johnson & Jennings Co., of Cleveland, Ohio; and at the plants of the Metal & Thermit Co. at San Francisco, Calif., East Chicago, Ind., and Chrome, N. J.

Several plants are equipped to handle 40,000 tons of old tin-coated containers but they have never operated at full capacity. In recent years only small quantities of old cans have been treated even when the price of tin was much higher than it was in 1928. The cost of collecting the old cans is too great to permit profitable operation. Five hundred tons of old cans was treated in 1928 for the recovery of tin coating; the plant at Los Angeles which operated in 1926 and 1927 was closed early in 1928. Some sash weights are still made in Philadelphia from the remelted old cans collected locally, but no effort was made to save any tin.

The tin reported recovered in alloys and compounds in 1928 included the tin content of products made from clean tin-plate scrap. Most of the tin recovered at the plants listed was in tin bichloride, tin tetrachloride, and tin oxide. As the products are made from scrap tin, and thus conserve the primary metal, they are properly regarded as recovered tin.

Tin-plate clippings imported in 1928 amounted to 10,473 short tons, of which 10,433 tons came from Canada. The western copper

mines continued to use baled detinned scrap to precipitate copper from mine waters. It is excellent for that purpose and is preferred to miscellaneous iron scrap.

It is estimated that about 29,500 short tons of tin was used in the United States in 1928 by the makers of tin plate and terneplate, and that the total recovery of secondary tin as metal and in compounds from tin-plate scrap in 1928 was about 3,090 tons.

The output of the silk industry has increased considerably during the last five years, and increasing quantities of tin have been used for weighting. There has been considerable comment on the increase in the percentage of tin used per pound of silk, and proposals have been made to limit the practice to a maximum allowance by weight. Because of the largely increased use of tin chloride and the increased recovery from waste solutions, an article written by Gibson Buttfield, of the Industrial Associates (Inc.), New York, and published in Chemical and Metallurgical Engineering, October, 1928, is of interest.¹¹

The following articles, written by E. R. Thews, on the recovery of tin and alloys containing tin are of interest:

Smelting Secondary Tin—the Metallurgical Treatment of Tin Residues: Metal Industry, September, 1927 (pp. 363-365), and October, 1927 (pp. 411-413).

The Production of White Bearing Metals and Tin Solders from Scrap Metals: Metal Industry, September, 1928 (pp. 394-396).

SECONDARY ANTIMONY

Secondary antimony recovered in, primary antimonial lead produced in, and antimony imported into and exported from the United States, 1927-28, in short tons

	1927	1928
Secondary antimony in antimonial-lead scrap smelted at regular smelters.....	1,039	1,355
Secondary antimony recovered at secondary smelters.....	11,361	10,545
	<u>12,400</u>	<u>11,900</u>
Primary antimonial lead produced at regular smelters.....	24,347	33,058
Antimony content of primary antimonial lead.....	2,736	3,432
Antimony imported in ore, as metal, or as oxide or salts.....	14,786	15,720
Foreign antimony exported.....	363	599

The production of secondary antimony in the United States in 1928, most of which was recovered in alloys, aggregated 11,900 short tons, a decrease of 4 per cent from the recovery in 1927. The average price of ordinary brands of antimony in 1928, as published by the American Metal Market, was 10.3 cents compared with 12.34 cents in 1927. Those smelters that ordinarily use primary ores, concentrates, or metal reported the recovery of 1,355 tons of antimony contained in 12,418 tons of antimonial lead scrap, or 316 tons more than they reported in 1927. The recovery of secondary antimony by the secondary smelters, on the contrary, showed a decrease of 816 tons from that in 1927. The imports of antimony in 1928 increased about 900 short tons, and the quantity of primary antimonial lead made at regular smelters increased more than 8,700 tons.

¹¹ Buttfield, Gibson, *Advances in Reclaiming Tin from Silk Weighting Washings*: Chem. and Met. Eng., October, 1928, p. 607.

There was an increase in the consumption of antimonial lead in batteries in 1928, as the automotive industry made a larger output than in 1927. The quantity used in other batteries and bearing metals was probably about the same as that used in 1927. Several secondary smelters estimated that the quantity of old battery plates shipped for smelting averaged more than 12,000 tons a month.

The principal materials refined or remelted that contained antimony as an alloy were hard-lead drosses, babbitt, bearing metal, battery plates, pewter, and type metal. The antimony used in the pigment, paint, and ceramic industries is so dissipated that no secondary recoveries can be made, but a large proportion of the production of metal containing antimony returns in a few months or a few years for refining and reuse. Dealers and brokers return much of the battery plates, and users of bearing metal and type metal regularly ship their used material to the makers of type metal and bearing metal and are credited with its value against the shipments of refined alloys.

Most of the old battery plates are collected by dealers and shipped to secondary smelters that buy them at a price based on the price of pig lead at St. Louis. The antimony content is paid for at the price of lead; this price in 1928 was 5.8 cents, or about 6.5 cents less than the average price of antimony. As antimony is used mainly in an alloy, it is seldom separated in refining scrap.

SECONDARY ALUMINUM

Secondary aluminum recovered in the United States, 1927-28, in short tons

	1927	1928
Secondary aluminum recovered unalloyed.....	23,000	24,500
Aluminum recovered in alloys (mainly No. 12).....	23,200	23,300
	46,200	47,800

Primary aluminum produced in the United States and imported and exported, 1927-28

	1927	1928
Value of primary aluminum produced in the United States.....	\$39,266,000	\$47,899,000
Aluminum (crude and semicrude) imported for consumption..... pounds..	62,575,222	33,847,007
Aluminum (crude and semicrude) exported..... do.....	14,522,560	15,728,281

The recovery of secondary aluminum as pig aluminum or in alloys amounted to 47,800 tons in 1928, valued at \$22,848,400, compared with 46,200 tons in 1927, valued at \$23,469,600.

Some of the larger secondary smelters, refiners, and users of aluminum in 1928 were as follows:

Aluminum Industries (Inc.), Cincinnati, Ohio.
 Apex Smelting Co., Chicago, Ill.
 Aurora Refining Co., Aurora, Ill.
 Bohn Aluminum & Brass Corporation, Detroit, Mich.
 Cleveland Electro Metals Co., Cleveland, Ohio.
 Federated Metals Corporation, New York, N. Y.
 Ford Motor Co., Detroit, Mich.
 General Metals Refining Co., St. Louis, Mo.

Globe Metal Co., Chicago, Ill.
Wm. F. Jobbins (Inc.), Aurora, Ill.
Lewin Metals Corporation, St. Louis, Mo.
The Maytag Co., Newton, Iowa.
Michigan Copper & Brass Co., Detroit, Mich.
Michigan Smelting & Refining Co., Detroit, Mich.
National Bronze & Aluminum Foundry Co., Cleveland, Ohio.
National Smelting Co., Cleveland, Ohio.
National Smelting & Refining Co., Detroit, Mich.
Niagara Falls Smelting & Refining Corporation, Buffalo, N. Y.
M. L. Oberdorfer Brass Co., Syracuse, N. Y.
Peninsular Smelting & Refining Co., Detroit, Mich.
South Bend Smelting & Refining Co., South Bend, Ind.
United States Aluminum Co., Cleveland, Ohio.
United States Reduction Co., East Chicago, Ind.

A large quantity of No. 12 secondary ingots (92 per cent aluminum and about 8 per cent copper) is made by smelters from old or defective castings, borings, and scrap, but the number of alloys containing aluminum has greatly increased in recent years, and the use of No. 12 alloy is proportionately less than it was.

Ernest V. Pannell, of the British Aluminum Co. (Ltd.), recently compiled a list of 65 casting alloys of aluminum, each of which had its distinctive properties and merits. He also states that there are probably 25 different compositions of forging alloys containing aluminum in use.

The scrap and waste aluminum available to foundry users and secondary smelters include chiefly drosses and skimmings, bearings, grindings and similar machining scrap, heavy cast scrap (principally automotive castings), fabricating scrap, and old sheet and utensils. Good clean aluminum scrap is comparatively scarce, and the quantity of dross from the melting of aluminum is small compared with the quantity of drosses and skimmings from aluminum alloys. Considerable waste aluminum came from the plants making electrolytic zinc.

In an article, entitled "Secondary Metal Versus Scrap in Aluminum Alloy Foundry Practice," contributed to the American Metal Market, March, 1927, Dr. Robert J. Anderson discusses the virgin character and uses of aluminum scrap and aluminum alloy scrap and its use by foundries as a substitute for primary aluminum or for ingots made by smelters from secondary material. His conclusion is that it is more satisfactory in most instances for a foundry to use purchased ingots made from scrap for the following reasons: The methods for the treatment of aluminum and aluminum alloys have been much improved so that high-grade secondary casting alloys are being made by reliable smelters that purchase scrap in large quantities; the purchase of miscellaneous scrap direct by the foundry is not as economical as it appears, even when aluminum recovery departments have been installed; the quality of aluminum alloy castings depends upon the metal used; and although good scrap can be bought the foundryman, unless he relies on strict chemical analysis of every lot of scrap purchased, is very apt to use inferior grades of scrap unfitted for his products. For some purposes virgin aluminum should be purchased, but the use of ingot of known analysis made from secondary metal should be encouraged so as to reduce the cost of castings.

The sources of aluminum and aluminum scrap alloys are as follows:

Clippings and sheets from utensils and automobile body works.

Foil, clean or coated.

Cable, clean or dirty.

Castings, pure or unalloyed, classified as (1) clean castings never in use, (2) dirty, reclaimed from machinery, and (3) dirty scrap cleaned.

Bearings, turnings, etc. (machine shops convert 10 to 12 per cent of rough castings into fine particles; their value depends on cleanliness).

Skimmings from melting (they vary widely in metal content).

Grindings and buffings.

Sludge—residue from refining operations, usually worthless.

Dross—aluminous oxide and metal from fluxing operations.

Under normal conditions remelt ingot will sell at about 4 cents a pound below 99 per cent virgin ingot, clippings at 7.5 cents below virgin ingot, clean scrap castings 10 cents below virgin ingot, and borings 15 cents below virgin ingot.

A series of articles relating to aluminum are as follows:

Anderson, Robert J., Hughes, George E., and Anderson, Marshall B., *Melting Aluminum in Large Quantities: Metal Industry*, April, 1929 (pp. 164-166).

Pannell, Ernest V., *Aluminum, Its Present and Future Status: Metal Industry*, January, 1929 (pp. 7-9); February, 1929 (pp. 72-73).

SECONDARY NICKEL

Secondary nickel recovered in the United States, 1927-28, in short tons

	1927	1928
Nickel recovered as metal.....	480	635
Nickel recovered in nonferrous alloys and salts.....	2,900	3,865
	3,380	4,500

Primary nickel produced in the United States and imported and exported, 1927-28, in short tons

	1927	1928
Nickel produced as a by-product from the electrolytic refining of copper at domestic refineries.....	860	522
Nickel imported for consumption in the United States as nickel or in nickel ores and matte, oxide, and alloys.....	20,489	34,664
Nickel, Monel metal, and other alloys exported.....	1,054	1,175

The nickel reported as recovered from secondary sources includes nickel in Monel metal (a natural alloy) but not that in ferrous alloys. Although the military use of nickel has declined to less than half its former quantity, the use of nickel in ferrous alloys is still the largest factor of consumption, so it is evident that the 4,500 tons of secondary nickel recovered from nonferrous sources in 1928 forms probably less than half the total recovered and reused.

The secondary nickel recovered from nonferrous sources in the United States in 1928 was equal to 13 per cent of the nickel imported; it was recovered mainly as Monel metal, old anodes, nichrome, and nickel silver. The quantity of secondary nickel recovered in 1928 was 4,500 tons, or 33 per cent more than in 1927. As the use of nickel and its alloys for kitchen and serving equipment, bath fixtures,

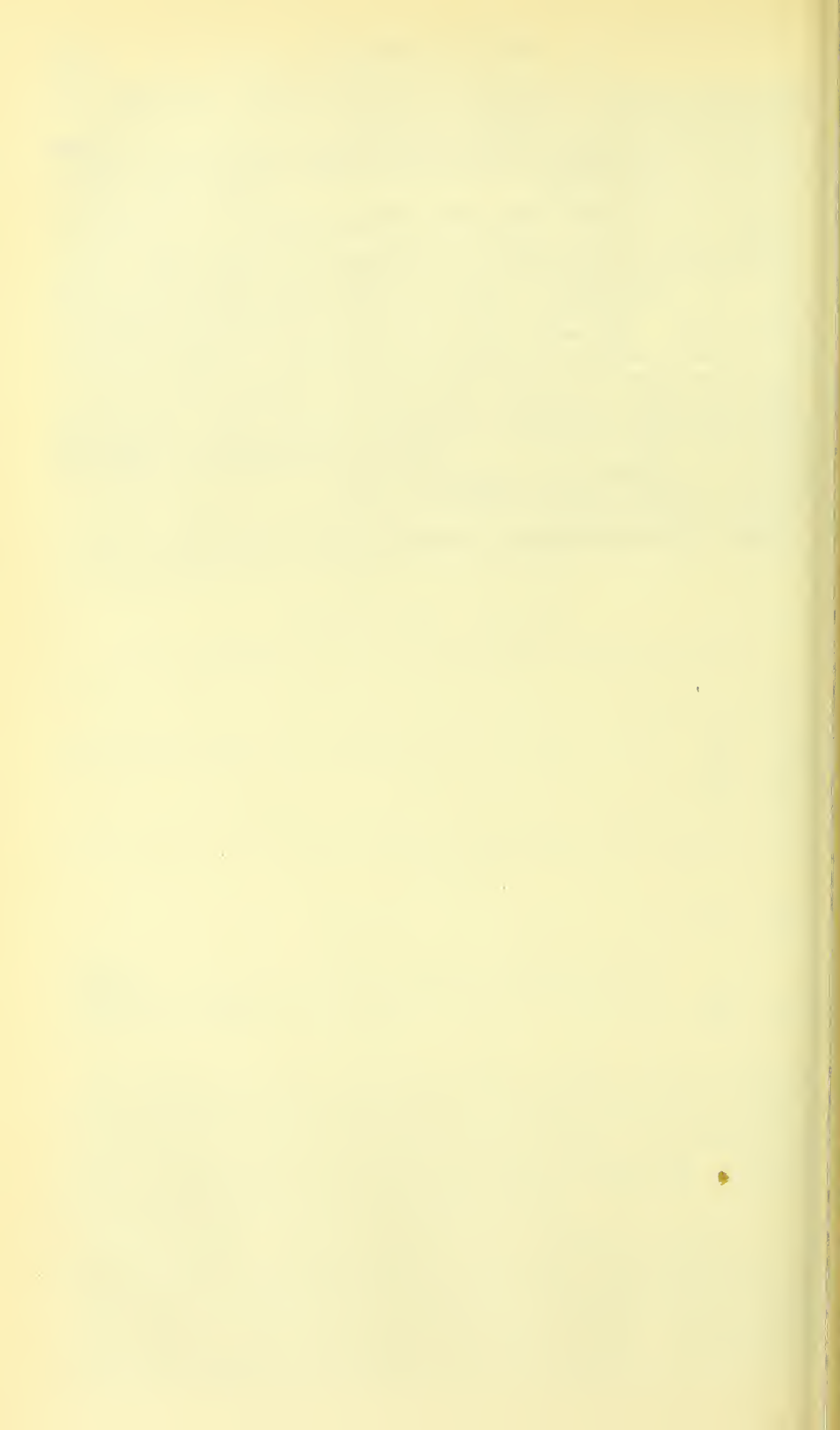
preserving kettles, and chemical utensils is rapidly expanding, the secondary recovery will continue to grow.

The beneficial use of nickel in some brasses and bronzes has been set forth by metallurgists, and its use for such purposes was considerably expanded in 1928.

Analyses of various nickel alloys were published in *Mineral Resources*, 1915.¹²

Considerable information as to the uses of nickel, Monel metal, and other nickel alloys is given in "Inco," the publication of the International Nickel Co. This company purchases nickel scrap and Monel scrap. A flat offer is made for metal containing not less than 64 per cent of nickel, not less than 27 per cent of copper, not more than 3½ per cent of iron, and not more than 0.05 per cent of sulphur. The scrap must be free from lead and zinc. If the scrap offered is not up to above specification, settlement will be made on a basis of nickel and copper content. As the cost of sampling and analyzing is high, it is necessary to avoid small shipments of scrap, and not less than 500 pounds should be offered for sale.

¹² Hess, F. L., *Nickel: Mineral Resources of the United States*, 1915, Pt. I, pp. 763-765.



SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES

(MINE REPORT)

By J. P. DUNLOP and H. M. MEYER

INTRODUCTION

The silver, copper, lead, and zinc mines of the Central States are in Arkansas, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States, which extends from the Appalachian system to the Rocky Mountain front, exclusive of the Black Hills. Most of the mines are in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

In the lead and zinc regions of the Central States the material sold is mainly concentrates,¹ and payment is made according to a basic price for concentrates of a certain quality. The details of this method are given in the pages devoted to Missouri in the report of this series for 1914. The figures reported by producers represent the quantity and assay contents of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted. In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced but not smelted during the year has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

TENOR OF ORES OF THE CENTRAL STATES

The only fair basis for comparison of the relative magnitude of mining operations in different States is that of quantity of crude ore, or "dirt." There are, however, marked differences in the metal content of the ores of the several mining regions and States, and therefore comparison of tenor of the ores is of interest and significance. All but a very small part of the ore from the Central States is of such tenor that it requires concentration. In Kentucky and southern Illinois most of the lead and zinc concentrates are recovered as by-products in the concentration of the fluorspar that they accompany, and it is not possible to calculate the metal content of the crude ore raised. In Arkansas very little ore has been mined for several years, and the average tenor calculated from the output of ore during these years would not present an accurate comparison with the tenor during a period of active mining.

¹ In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

Quantity and tenor of copper, lead, and zinc ores, old tailings, etc., produced in the Central States, 1926-1928, by States

State	1926		1927		1928	
	Ore	Metal content ¹	Ore	Metal content ¹	Ore	Metal content ¹
	<i>Short tons</i>	<i>Per cent</i>	<i>Short tons</i>	<i>Per cent</i>	<i>Short tons</i>	<i>Per cent</i>
Illinois (northern)-----	245, 100	1. 49	88, 200	0. 82	(?)	(?)
Kansas-----	4, 717, 500	3. 66	4, 505, 800	3. 38	4, 662, 200	3. 16
Michigan-----	7, 641, 682	1. 15	8, 046, 334	1. 10	7, 361, 658	1. 21
Missouri-----	7, 287, 100	3. 30	6, 824, 000	3. 28	6, 573, 800	3. 26
Oklahoma-----	10, 934, 000	3. 48	9, 932, 400	2. 89	8, 028, 000	2. 97
Wisconsin-----	1, 446, 300	2. 51	1, 480, 800	2. 93	733, 500	3. 49
	32, 265, 682	-----	30, 877, 534	-----	27, 359, 158	-----

¹ The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper; in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of tenor of ore given in the sections devoted to the respective States.

² No ore milled; concentrates shipped were from ore milled in 1927.

The marked loss in the quantity of ore and tailings treated in 1928 in the Central States was shared by copper and zinc properties. There was a decrease of 8.5 per cent in the output of copper ore from Michigan, although the yield of copper showed a small increase. The quantity of ore and tailings from lead and zinc mines treated in 1928 decreased in Illinois, Wisconsin, Missouri, and Oklahoma. The quantity of crude ore from Kansas mines treated in 1928 was less than in 1927, but the quantity of old tailings milled increased considerably (more than 600,000 tons). The decrease in the quantity of zinc and zinc-lead ores in Wisconsin was 50 per cent, although there was a fair increase in the tenor of the ore milled. No lead or zinc ore was milled in Illinois in 1928.

The average tenor of ore treated in the Central States in 1928 is best indicated by the average value of the total metal content, which was only \$3.49 a ton of ore treated. This value was \$0.05 more than in 1927, owing to the higher average price of copper and the increased recovery of copper at Michigan mines. The 19,997,500 tons of zinc, lead, and lead-zinc ores, old tailings, etc., treated in the Central States, exclusive of the small output of Arkansas and Kentucky, in 1928 yielded lead and zinc concentrates that sold for \$49,324,679; consequently the mine operators realized an average of \$2.47 a ton of ore, etc., mined and treated, compared with \$2.65 a ton in 1927. The value of both lead and zinc concentrates was much less in 1928 than in 1927. The quantity of lead concentrates marketed decreased about 20,600 tons and that of zinc concentrates about 133,200 tons. Only a small quantity of flotation concentrates was produced in Wisconsin and southwestern Missouri. Mills in southeastern Missouri, Kansas, and Oklahoma are usually equipped with flotation units; about 111,400 tons of zinc concentrates and 102,700 tons of lead concentrates were recovered at these mills in 1928 by the flotation process.

SUMMARY

The total value of the mine production of silver, copper, lead, and zinc in the Central States in 1928 was \$95,665,149, or \$10,424,059 less than the value in 1927. The total value from 1907 to 1928 was \$2,214,249,116—\$872,883,660 for zinc, \$702,301,940 for copper, \$631,842,768 for lead, and \$7,220,748 for silver. The value of the

zinc has been much greater than that of the copper for the last 10 years; hence the total value of the zinc produced during the period is \$170,582,000 more than that of the copper.

The value of metal production herein reported has been calculated at the figures given in the table that follows. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

Mine production of silver, copper, lead, and zinc in the Central States in 1928, by States

State	Silver		Copper		Lead		Zinc		Total value
	Fine ounces	Value	Pounds	Value	Short tons	Value	Short tons	Value	
Arkansas.....					38	\$4,408	86	\$10,492	\$14,900
Illinois.....	3,146	\$1,840			385	44,660	17	2,074	48,574
Kansas.....					25,276	2,932,016	107,251	13,084,622	16,016,638
Kentucky.....					39	4,524	92	11,224	15,748
Michigan.....	17,153	10,035	178,442.704	\$25,695,749					25,705,784
Missouri.....	176,840	103,451	65,000	9,360	195,393	22,665,588	12,974	1,582,828	24,361,227
Oklahoma.....					43,687	5,067,692	180,252	21,990,744	27,058,436
Wisconsin.....					1,698	196,968	18,417	2,246,874	2,443,842
Total, 1927..	197,139	115,326	178,507.704	25,705,109	266,516	30,915,856	319,089	38,928,858	95,665,149
	332,642	188,608	177,988,775	23,316,530	280,445	35,336,070	369,125	47,248,000	106,089,208

Silver.—Nearly all the silver that has been produced in the Central States has been recovered incidentally in the production of other metals. The output in 1928 from the copper lodes of Michigan decreased 80,040 ounces from 1927. There has been a great decline in the silver from this source in recent years. The silver derived from the treatment of lead ore from southeastern Missouri decreased 57,091 ounces in 1928. The lead-zinc fluorspar deposits of the Kentucky-Illinois field also carry silver, and the silver recovered from the lead concentrates shipped from Illinois in 1928 was 3,146 ounces, an increase of 1,628 ounces.

Copper.—The mine production of copper in the Central States in 1928 was nearly all from Michigan, which contributed 178,442.704 pounds, or 904,929 pounds more than in 1927. The copper mines in Missouri did not ship any ore or concentrates in 1928, and the small output—65,000 pounds—was derived from copper-lead matte from lead smelters. As this matte contains nickel and cobalt and

the refineries have considerable stocks of such material, it was difficult to dispose of the copper-lead matte on favorable terms. The matte sold in 1928 was exported.

Lead.—The mine production of lead in the Central States in 1928 decreased 5 per cent in quantity and 12.5 per cent in value. Missouri produced 73 per cent of the total, compared with 71 per cent in 1927, and the recoverable lead content of galena and lead carbonate concentrates mined in Missouri in 1928 was equivalent to 31.2 per cent of the refined primary lead recovered in the United States from domestic ore during that year. Of the total output of lead in Missouri the disseminated lead district of southeastern Missouri produced 194,270 tons, which was more than the output of any State or other district in the United States. Southwestern Missouri had an output of 1,123 tons of lead, or 1,386 tons less than in 1927. The production of lead in Oklahoma, as measured by the recoverable metal in concentrates sold or treated, decreased from 51,680 tons in 1927 to 43,687 tons in 1928. The production from Kansas mines decreased from 27,497 tons in 1927 to 25,276 tons in 1928 and that from Wisconsin mines from 2,069 to 1,698 tons. Production from Illinois mines increased from 277 to 385 tons. The combined output of lead from mines in Arkansas, Illinois, Kentucky, and Wisconsin amounted to less than 1 per cent of the total output of the Central States. The yield of lead from mines in Arkansas and Kentucky was very small in 1928, and no lead was produced in Iowa.

Zinc.—The mine production of zinc in the Central States in 1928 was equivalent to 54 per cent of the total smelter output of primary slab zinc from domestic ores in the United States as compared with 64 per cent in 1927. Oklahoma produced 180,252 tons of zinc in 1928, compared with 206,611 tons in 1927. For many years prior to 1918 Missouri was the largest producer of zinc in the United States; in 1928, however, the output was only 12,974 tons, whereas in 1917 it was 132,918 tons. The output of zinc in Kansas rose from 56,225 tons in 1922 to 126,307 tons in 1926 and then decreased to 109,427 tons in 1927 and to 107,251 tons in 1928. In Wisconsin many of the mines were inactive, and the output of zinc declined from 32,841 tons in 1927 to 18,417 tons in 1928. The Arkansas output decreased from 128 tons in 1927 to 86 tons in 1928. Illinois and Kentucky are not large producers of zinc, and their output was much less in 1928 than in 1927. The Illinois output declined from 521 to 17 tons and that of Kentucky from 860 to 92 tons. No production of zinc has been reported from Iowa mines for a numbers of years.

PRODUCTION OF LEAD AND ZINC BY REGIONS

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to a single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary, but for practical purposes it is desirable to show the production by the natural regions, irrespective of State lines.

The seven regions, in order of size of output, are: (1) The Joplin region, comprising southwestern Missouri, southeastern Kansas, and northeastern Oklahoma; (2) southeastern Missouri, containing the great deposits of disseminated lead; (3) the upper Mississippi Val-

ley region, including all the lead and zinc mines in southwestern Wisconsin, Iowa, and northwestern Illinois; (4) the fluorspar region in southern Illinois and western Kentucky; (5) Arkansas; (6) central Missouri; (7) the Arbuckle Mountain region, in southern Oklahoma.

The southeastern Missouri region produced 73 per cent of the lead output of the Central States and 31 per cent of the primary lead recovered from domestic ore smelted or refined in the United States in 1928. The Joplin region yielded 26 per cent of the lead and 93 per cent of the zinc of the Central States in 1928 and was much the largest producer of zinc in the United States, yielding 50 per cent of the total slab zinc produced from domestic ores in 1928 and 57 per cent of the total in 1927.

The lower zinc content of the zinc concentrates produced at mines in the upper Mississippi Valley region is clearly indicated by the fact that, although these mines yielded 11 per cent of the total output of raw zinc concentrates of all classes, the zinc content of such concentrates was only 6 per cent of the zinc from mines in the Central States.

The lead content of the galena concentrates shipped from the upper Mississippi Valley region averaged about 71.7 per cent, that of the concentrates from the Joplin region averaged about 78.8 per cent, and that of the concentrates from the southeastern Missouri region averaged 72.1 per cent. A very small proportion of the galena shipped from the Joplin region contained more than 82 per cent lead. A large part of the sphalerite shipped from the Joplin region contained 58 to 60 per cent of zinc, and more than 29,000 tons shipped from the Waco and Smithfield districts in that region averaged 61 per cent.

Mineral Resources for 1914 contains brief reviews of the history of lead and zinc mining in the Central States, the yearly production of each State for the period 1907 to 1914, inclusive, and historical notes and estimates of the total production of lead and zinc in each State before 1907.

Mine production of lead and zinc in the Central States in 1928, by regions

Region	Lead ¹		Zinc ²		Total value
	Short tons	Value	Short tons	Value	
Concentrates:					
Joplin.....	90, 833	\$7, 327, 850	576, 787	\$21, 222, 225	\$28, 550, 075
Southeastern Missouri.....	274, 925	19, 107, 891	6, 597	236, 111	19, 344, 002
Upper Mississippi Valley ³	2, 425	177, 792	72, 267	1, 254, 475	1, 432, 267
Kentucky-southern Illinois.....	648	48, 433	265	6, 032	54, 465
Northern Arkansas.....	50	4, 010	224	5, 600	9, 610
Total, 1927.....	368, 881	26, 665, 976	656, 140	22, 724, 443	49, 390, 419
	389, 518	32, 913, 320	789, 342	27, 680, 940	60, 594, 260
Metal:					
Joplin.....	70, 086	8, 129, 976	297, 020	36, 236, 440	44, 366, 416
Southeastern Missouri.....	194, 270	22, 535, 320	3, 457	421, 754	22, 957, 074
Upper Mississippi Valley ³	1, 706	197, 896	18, 434	2, 248, 948	2, 446, 844
Kentucky-southern Illinois.....	416	48, 256	92	11, 224	59, 480
Northern Arkansas.....	38	4, 408	86	10, 492	14, 900
Total, 1927.....	266, 516	30, 915, 856	319, 089	38, 928, 858	69, 844, 714
	280, 445	35, 336, 070	369, 125	47, 248, 000	82, 584, 070

¹ Includes galena and a very small quantity of lead carbonate concentrates.

² Includes sphalerite and less than 2,500 tons of zinc carbonate and zinc silicate concentrates.

³ Includes Iowa, northern Illinois, and Wisconsin.

REVIEW BY STATES AND DISTRICTS

ARKANSAS

By J. P. DUNLOP

The value of the lead and zinc from Arkansas mines was \$1,430,668 in 1917, but only \$14,900 in 1928.

The production of galena in Arkansas is small. The shipments of zinc carbonate and zinc silicate concentrates in 1928—224 tons—were less than 2 per cent of the shipments in 1917.

Mine production of lead and zinc in Arkansas, 1919–1928

Year	Lead concentrates (galena)		Zinc concentrates				Metal content ¹			
			Sphalerite		Silicate and carbonate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919.....	35	\$2,400	-----	-----	510	\$18,170	28	\$2,968	189	\$27,594
1920.....	10	755	-----	-----	917	28,925	8	1,280	329	53,298
1921.....	27	1,510	-----	-----	42	580	21	1,890	15	1,500
1922.....	55	4,000	-----	-----	425	6,870	42	4,620	134	15,276
1923.....	32	2,559	-----	-----	444	9,919	25	3,500	148	20,128
1924.....	25	2,730	-----	-----	13	330	20	3,200	4	520
1925.....	93	8,546	58	\$2,380	44	1,296	58	10,092	43	6,536
1926.....	28	2,544	8	346	246	7,012	18	2,880	87	13,050
1927.....	30	2,590	-----	-----	386	9,453	23	2,898	128	16,384
1928.....	50	4,010	-----	-----	224	5,600	38	4,408	86	10,492

¹ In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc in 1921 to 1928. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and concentrates produced in Arkansas, 1925–1928

	1925	1926	1927	1928
Total ore.....short tons.....	(1)	(1)	(1)	(1)
Average lead content of galena concentrates.....per cent.....	63.4	64.0	78	76
Average zinc content of zinc silicate and carbonate.....do.....	44.0	37.4	38	43
Average value per ton:				
Galena concentrates.....	\$91.89	\$90.86	\$86.33	\$80.20
Zinc silicate and carbonate.....	\$29.45	\$28.50	\$24.49	\$25.00

¹ The quantity of ore mined was very small, and very little of it was milled, so that no calculations as to tenor are available; part of the ore sold was taken from stock in bins.

The mines are chiefly in Boone and Marion Counties and the adjoining portions of Searcy and Newton Counties, but there are numerous prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and deposits have been worked in Washington and Sevier Counties, on the extreme western border of the State, and in Pike County, in the southwestern part of Arkansas.

The ores are galena, sphalerite, and smithsonite, and the concentrates produced are generally of high grade and free or nearly free from iron or lime. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, especially in a yellow variety of smithsonite known locally as "turkey fat," which shows as much as 0.8 per cent of cadmium. This was the highest content reported for zinc concentrates for the Central States

until 1927, when shipments of blende concentrates from southeastern Missouri were reported as assaying 1 per cent of cadmium.

In 1928, as in 1927, few of the lead and zinc mines of Arkansas were worked and none were operated for any long period, nor was there any development of importance. Shipments of lead and zinc ores in 1928 came from four small mines, and the value of the concentrates shipped decreased from \$12,043 in 1927 to \$9,610 in 1928.

No shipments of zinc concentrates were reported from Lawrence and Newton Counties. All of the galena shipments were from the Brewer property in Newton County, and all of the zinc carbonate shipments were from Marion County. Most of the shipments of zinc carbonate were from the Morning Star mine at Rush Creek, where the 350-ton mill was operated for a short time. The recovery at the Morning Star mine was good, but the demand for concentrates was not sufficient and the price offered was too small to warrant steady operation. Work will be resumed when conditions are more favorable.

ILLINOIS

By J. P. DUNLOP

Mine production of lead and zinc in Illinois in 1928, by districts¹

District	Lead concentrates (galena)		Zinc concentrates (sphalerite)		Metal content ²			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Northern Illinois.....	11	\$841	69	\$824	8	\$928	17	\$2,074
Southern Illinois.....	589	43,474	377	43,732	377	43,732	17	2,074
Total, 1927.....	600	44,315	69	824	385	44,660	17	2,074
	420	29,772	2,726	30,722	277	34,902	521	66,688

¹ Mineral Resources for 1914 contains a historical review of lead and zinc mining in Illinois.

² In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and concentrates produced in Illinois, 1925-1928

	1925	1926	1927	1928
NORTHERN ILLINOIS				
Total ore.....short tons..	232,000	245,100	88,200	(1)
Total concentrates in ore:				
Lead.....per cent..	0.27	0.15	0.12	
Zinc.....do.....	4.87	5.37	3.09	
Metal content of ore:				
Lead.....do.....	0.21	0.11	0.08	
Zinc.....do.....	1.28	1.38	0.74	
Average lead content of galena concentrates.....do.....	78.6	77.9	66.4	78.0
Average zinc content of sphalerite concentrates.....do.....	26.3	25.6	23.6	27.5
Average value per ton:				
Galena concentrates.....	\$105.71	\$104.02	\$72.74	\$76.46
Sphalerite concentrates.....	\$15.64	\$13.65	\$11.27	\$11.94
SOUTHERN ILLINOIS				
Average lead content of galena concentrates.....per cent..	67.0	64.2	67.4	65.4
Average zinc content of sphalerite concentrates.....do.....	59.9			
Average value per ton of galena concentrates.....	\$95.26	\$94.28	\$70.23	\$73.81

¹ Concentrates shipped were milled in 1927.

Mine production of silver in southern Illinois, 1919-1928

Year	Silver		Lead concentrates, silver-bearing		Year	Silver		Lead concentrates, silver-bearing	
	Fine ounces	Value	Short tons	Ounces of silver per ton		Fine ounces	Value	Short tons	Ounces of silver per ton
1919.....	4, 440	\$4, 973	715	6. 16	1924.....	8, 891	\$5, 957	1, 678	5. 30
1920.....	8, 193	8, 930	1, 252	6. 55	1925.....	3, 000	2, 082	797	3. 76
1921.....	1, 345	1, 345	181	7. 43	1926.....	2, 990	1, 866	614	4. 87
1922.....	6, 025	6, 025	1, 100	5. 48	1927.....	1, 518	861	310	4. 90
1923.....	8, 170	6, 699	1, 762	4. 64	1928.....	3, 146	1, 840	589	5. 34

The value of the mine production of silver, lead, and zinc in Illinois in 1928 was \$48,574 as compared with \$102,451 in 1927.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineral associations and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

NORTHERN ILLINOIS

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwestern county of the State. The ores are galena, smithsonite, and sphalerite, although the first two are much less common now than formerly, when most of the deposits worked were shallow and above water level.

The entire output of northern Illinois is included under the Galena district, which comprises the mines from the vicinity of Fever River to the Wisconsin State line.

No mills were operated in northern Illinois in 1928, practically no lead and zinc ore was mined, and very little prospecting was done. Only 11 tons of galena and 69 tons of sphalerite concentrates were shipped. The shipments were clean-ups from 1927 operations, and the sphalerite was nearly all from the stock pile of the Hollander tailing mill. The famous old Black Jack mine of the Mineral Point Zinc Co. was closed in 1927, and Vinegar Hill Zinc Co. operations were confined to drilling one lease.

SOUTHERN ILLINOIS

The lead and zinc deposits of southern Illinois are in Pope and Hardin Counties; they occur in rocks of Mississippian age in the northern extension of the Kentucky-Illinois fluorspar district. The chief product of the mines in recent years has been fluorspar, and the yield of galena is small, compared with the output from other districts in the Central States.

The total production of galena concentrates in southern Illinois from 1906 to 1928 has been 16,741 tons, most of which has been shipped from the Fairview, Rosiclare, and Hillside mines. The shipments of zinc ores from the district have been comparatively small and scattered. The only recorded shipments of zinc carbonate, aggregating 103 tons, were made from the Empire mine in 1903 or 1904 and from four companies in 1906.

Formerly large bodies of galena near the surface were worked, but galena is now produced incidentally in the concentration of the fluorspar; for this reason it would be misleading to give the quantity of crude ore. The galena of southern Illinois is notably argenticiferous as compared with the rest of the Mississippi Valley ores, and the silver content averaged between 3.76 and 7.43 ounces to the ton of lead concentrate for the last 12 years.

Sphalerite, or zinc blende, occurs much less plentifully than galena. The first large shipments of sphalerite in many years were made in 1924 from the 250-ton plant of the Fairview Fluorspar & Lead Co., which reported no sales of sphalerite in 1926, 1927, and 1928.

The quantity of galena concentrates shipped from southern Illinois increased from 310 tons in 1927 to 589 tons in 1928. The Rosiclare Lead & Fluorspar Mining Co. reported a small quantity of silver-bearing galena shipped in 1928. Most of the output was from the Hillside Fluor Spar mines near Rosiclare. Two shafts were operated, and the ore was treated at the 200-ton mill. The galena concentrate, assaying 65 per cent of lead and about 5 ounces of silver a ton, was shipped to the St. Louis plant of the National Lead Co.

IOWA

The lead and zinc deposits of Iowa extend along the Mississippi River for nearly 80 miles, in Dubuque, Clayton, and Allamakee Counties. No shipments of lead or zinc concentrates from mines in Iowa have been reported since 1917.

KANSAS

By J. P. DUNLOP

Mine production of lead and zinc in Kansas in 1928, by districts

District	Lead concentrates ¹		Zinc concentrates		Metal content ²			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Blue Mound-Baxter Springs	30,399	\$2,462,391	173,424	\$6,502,739	23,719	\$2,751,404	90,864	\$11,085,408
Westline	1,601	128,598	7,090	249,280	1,254	145,464	3,740	456,280
Galena	1,417	28,941	836	31,935	303	35,148	380	46,360
Waco			23,072	897,608			12,267	1,496,574
Total, 1927	32,417	2,619,930	204,332	7,650,962	25,276	2,932,016	107,251	13,084,622
	35,622	3,140,591	211,688	8,441,140	27,497	3,464,622	109,427	14,006,656

¹ Includes 106 tons of lead carbonate, containing 63 per cent lead, from Galena.

² In calculating the metal content of the ores from assays allowance has been made for smelting losses both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and old tailings milled and concentrates produced in Kansas, 1927-28

	1927		1928	
	Crude ore	Old tailings	Crude ore	Old tailings
Total ore and old tailings milled.....short tons..	4,008,100	497,700	3,547,100	1,115,100
Total concentrates recovered:				
Galena.....do.....	35,416	52	32,259	158
Sphalerite.....do.....	205,109	6,579	186,113	18,219
Ratio of concentrates to ore, etc.:				
Lead.....per cent.....	0.89	0.01	0.91	0.01
Zinc.....do.....	5.12	1.32	5.17	1.63
Metal content of ore, etc.:				
Lead.....do.....	0.70	0.01	0.72	0.01
Zinc.....do.....	3.01	0.71	3.09	0.93
Average lead content of galena concentrates.....do.....	78.9	60.0	79.6	77.8
Average zinc content of sphalerite concentrates.....do.....	58.9	53.4	59.8	56.6
Average value per ton:				
Galena concentrates.....	\$88.34	\$59.42	\$80.09	\$74.85
Sphalerite concentrates.....	\$40.15	\$31.32	\$38.08	\$32.67

Tenor of lead and zinc ore and old tailings milled and concentrates produced in Kansas, 1925-1928

	1925	1926	1927	1928
Total ore and old tailings milled.....short tons..	4,165,000	4,717,500	4,505,800	4,662,200
Total concentrates in ore, etc.:				
Lead.....per cent.....	0.76	0.81	0.79	0.69
Zinc.....do.....	5.52	5.12	4.70	4.33
Metal content of ore, etc.:				
Lead.....do.....	0.60	0.62	0.62	0.55
Zinc.....do.....	3.27	3.04	2.76	2.61
Average lead content of galena concentrates.....do.....	78.9	79.1	78.9	79.6
Average zinc content of sphalerite concentrates.....do.....	59.1	59.0	58.8	59.0
Average value per ton:				
Galena concentrates.....	\$115.39	\$104.92	\$88.30	\$80.90
Sphalerite concentrates.....	\$52.70	\$48.03	\$39.88	\$37.60

The lead and zinc deposits of Kansas, so far as developed, are limited to Cherokee County, in the southeastern part of the State. They form the western extension of the ore deposits of the Joplin region and display the general characteristics shown in that region, except that here typical sheet-ground deposits have not been extensively developed.

It is difficult to ascertain the production for early years or to segregate the Kansas ores from those produced in the Missouri portion of the Joplin region. If to the figures for 1886 to 1903, published by the Kansas Geological Survey,² are added those for 1904 to 1928, published in Mineral Resources of the United States, a total of 2,791,590 tons of zinc concentrates and 430,205 tons of lead concentrates is shown as the approximate production of Kansas from 1886 to 1928. About 66 mines, of which 46 are in the Blue Mound-Baxter area, shipped lead or zinc in 1928.

The older mining area at Lawton and Badger-Peacock was not productive in 1928, and shipments of lead and zinc from the Galena district were small. Most of the production came from the Blue Mound-Baxter district, an extension of the Miami field, with substantial outputs from the Waco and Crestline districts. The output

² Haworth, Erasmus, and others, History, Geography, and Metallurgy of Galena-Joplin Lead and Zinc: Univ. Kansas Geol. Survey, vol. 8, 1904.

of galena from the Crestline district declined, but that of sphalerite concentrates increased 360 tons in 1928. The Kansas side of the Waco camp produced 23,072 tons of sphalerite in 1928, which was 5,403 tons more than in 1927; the total decrease in zinc concentrates from Kansas in 1928 was 7,356 tons.

Shipments of galena from Kansas mines declined 3,205 tons; the Galena camp with a small output was the only one that had larger shipments in 1928 than in 1927.

Blue Mound-Baxter Springs district.—The shipments of concentrates from the entire Blue Mound-Baxter Springs area in 1928 amounted to 30,399 tons of galena and 173,424 tons of sphalerite compared with 32,080 tons of galena and 187,239 tons of sphalerite in 1927. The average lead content of the galena sold in 1928 was 79.3 per cent, and the zinc content of the sphalerite was 59.4 per cent. The quantity of crude ore milled decreased, but there was a large increase in the quantity of old tailings treated in 1928. The crude ore (tailings excluded) milled in 1928 yielded 6.28 per cent in concentrates compared with 6.33 per cent in 1927. About 71 per cent of the galena and 74 per cent of the sphalerite shipped from the district came from mines in the vicinity of Blue Mound; these mines shipped 21,576 tons of galena and 128,815 tons of sphalerite. The mines north of Hockerville and near Baxter Springs in Kansas shipped 8,823 tons of galena and 44,609 tons of sphalerite.

Considerably fewer drill rigs prospected new territory in the Blue Mound-Baxter Springs area in 1928 than in 1927 and few mills were built. The Melrose camp in the extreme western part of the district was inactive, although there was some inquiry for leases late in the year. The depth of the ore bodies and the water always encountered in opening a new camp discouraged operations and will continue to do so until prices for zinc increase or the output of old camps declines.

New mills built in 1928 in the Blue Mound-Baxter Springs district were the Ballard (500 tons), the Brugger (200 tons), and the Hartley & Grantham (350 tons). The Brugger and the Hartley & Grantham are owned by the Century Zinc Co., which purchased the Brugger mine from the Vantage Mining Co. The Empire Development Co. ran its mine and mill for about six months, then sold the property to the Iron Mountain Lead & Zinc Co. The Homestake mine of the Federal Mining & Smelting Co. was sold late in December, 1928, to the Paul Revere Mining Co. The Commerce Mining & Royalty Co. postponed the erection of the new mill on the Paxton lease until 1929, although shafts have been sunk and pumping was continued. The St. Louis Smelting & Refining Co. finished the new 500-ton plant (of steel construction) on the Ballard lease and had the ground opened ready for operations early in 1929. The Velie Mines Corporation's Leopard 500-ton mill (of steel construction) began operating early in 1928 and was a large producer of both lead and zinc concentrates. The picking plant at the 500-ton mill on the Hartley lease of the Interstate Zinc & Lead Corporation was successfully run on crude ore. A large quantity of tailings was also treated.

The producing properties near Baxter Springs and north of Hockerville and Zincville in 1928 were the Barnsdall No. 6, Brugger,

Euterpe, Hanenkratt, Harrington, Hartley, Iron Mountain, Kansas Line, Laclede (tailing mill), Leopard, Madison, Matthiessen & Hegeler, Peru, Sonny Boy, and Western. The producing properties at Blue Mound and west and northwest of Blue Mound were the Barr, Bendelari, Big John, Black Eagle, Blue Mound, Boska, Cherokee, Chubb, Consolidated Nos. 7, 10, and 14, Early Bird (tailings), Fox, Kansouri, King Brand, Lawyers, Lucky Jew, Monarch, Northern, Robinson, Tri State (tailings), Webber, West Side, and Wilbur.

The mines that shipped more than 500 tons each of galena in 1928 were the Barr, Big John, Black Eagle, Blue Mound, Brugger, Consolidated No. 14, Fox, Hanenkratt, Hartley, Iron Mountain, King Brand, Lawyers, Leopard, Monarch, Northern, Robinson, Sonny Boy, Webber, and Wilbur.

The mines that shipped more than 3,000 tons each of sphalerite in 1928 were the Barr, Bendelari, Black Eagle, Blue Mound, Boska, Cherokee, Chubb, Consolidated Nos. 10 and 14, Early Bird (tailings), Euterpe, Hartley (Century Zinc Co.), Iron Mountain, Kansouri, King Brand, Lawyers, Leopard, Lucky Jew, Monarch, Northern, Peru, Robinson, Sonny Boy, Tri State (tailings), Webber, West Side, and Wilbur.

Crestline district.—The production in the Crestline district in 1928 was 1,601 tons of galena and 7,000 tons of sphalerite, compared with 3,181 tons of galena and 6,640 tons of sphalerite in 1927.

Very little drilling was done in 1928 and fewer mines were operated, although the shipments of sphalerite increased. The Crutchfield mine and mill were idle most of the year, and shipments were much less than in 1927. Considerable galena and a small quantity of sphalerite were shipped from the Andrew Bros. mine. Operations at the mill were spasmodic.

The Crestline Products & Service Co., operating two 300-ton mills, produced more than 90 per cent of the sphalerite shipped. Both mills are now equipped with flotation plants, and three shafts were used to mine ore from the 200-foot level. The Dutch Boy Mining Co. produced very little sphalerite at its 200-ton mill, but it shipped more than half of all the galena from the district. This company was one of the few operating in the Joplin region whose output was composed almost entirely of galena.

Galena district.—The production of lead concentrates in the Galena district in 1928 was 311 tons of galena and 106 tons of lead carbonate, as compared with 207 tons of galena and 154 tons of lead carbonate in 1927. The shipments of sphalerite increased from 140 tons in 1927 to 836 tons in 1928, most of which was from the Shoal Creek mine on the Connor land. The lead concentrates were produced by small operators working in upper levels, as the old mine workings are cut together and are full of water. It will require concerted operation to unwater most of the old leases. So far no success has come from the attempt to lease all the lands to one operator, so that the district can be dewatered. Another effort will probably be made in 1929. The Cygni Mining Co.'s 100-ton mill on the Wyandotte land was operated a short time in 1928. The other shipments of sphalerite in 1928 were made by C. W. Squires, who operated a rock-crushing plant equipped with tables to recover sphalerite from the fines.

Waco district.—The total output of the Waco district in 1928 was 26,156 tons of sphalerite and 62 tons of galena as compared with 25,622 tons of sphalerite and 168 tons of galena in 1927. The district lies partly in Missouri and partly in Kansas; the production of the mines in the Kansas part of the district in 1928 was 23,072 tons of sphalerite as compared with 17,669 tons in 1927. Nearly all the output in Kansas in 1928 was from the Butte-Kansas and the Acme mines of the Missouri-Kansas Zinc Corporation and from old tailings milled by the same operators. Three shafts were used to hoist ore mined at 220 to 300 feet; most of the ore was from the lower levels. Each of the mills has a capacity of 500 tons. The corporation also operates the old Barnsdall No. 3 mill and the Dayton flotation plant and was the seventh largest producer of sphalerite in the Joplin region in 1928. The Grasselli mine and 300-ton mill were idle in 1928, although some concentrates were shipped from stock pile. The property was purchased in 1928 by the St. Louis Smelting & Refining Co. and was being thoroughly drilled by its new owners. The company located new ore which will be milled when operations are resumed.

KENTUCKY

By J. P. DUNLOP

Lead and zinc deposits occur in both central and western Kentucky. The central districts have not reported any shipments of lead or zinc for more than a score of years. The deposits in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston Counties and form a continuation of those in the southern Illinois lead and zinc region.

Considerable quantities of galena ores have been produced in former years, but at present lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, and its silver content ranges from a very small quantity to more than 3 ounces a ton, but no recovery of this silver content has been reported by the smelters for many years.

Mine production of lead and zinc in Kentucky, 1919-1928

Year	Lead concentrates (galena)		Zinc concentrates				Metal content			
			Sphalerite		Zinc carbonate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	120	\$7,250			120	\$3,600	86	\$9,116	36	\$5,256
1920	172	12,295			25	750	122	19,520	9	1,458
1921	100	3,693			621	19,800	69	6,210	220	22,000
1922	132	8,365			419	8,373	92	10,120	142	16,188
1923	78	6,152			850	17,925	53	7,420	270	36,720
1924	259	22,908			1,494	37,000	175	28,000	492	63,960
1925	251	23,619			1,217	29,740	152	26,448	429	65,208
1926	92	7,537	582	\$17,471	4,478	116,417	58	9,280	1,838	275,700
1927	241	14,070	352	5,392	2,136	46,514	139	17,514	860	110,080
1928	59	4,959			265	6,032	39	4,524	92	11,224

The total value of the lead and zinc concentrates shipped from Kentucky mines in 1928 was \$10,991, compared with \$65,976 in 1927. The Lafayette Fluorspar Co., which has a 75-ton mill equipped with Richards jigs, was the largest shipper of galena in 1928. The small output of zinc carbonate was shipped by the Zinc & Spar Co., near Salem, in Livingston County, and by the Sheridan Zinc & Mining Co. Both companies operate log washers. Most of the zinc carbonate shipped by the Sheridan Zinc & Mining Co. was mined in 1927. The Sheridan mine contains zinc sulphide in the lower levels, but it has not been mined and will not be hoisted until a concentrating plant is built.

MICHIGAN

By H. M. MEYER

The mines of Michigan produced 7,361,658 tons of rock in 1928, which yielded 283,405,073 pounds of concentrates, compared with 8,046,334 tons of rock and 275,460,828 pounds of concentrates in 1927. In spite of the large decrease in the production of rock, the production of copper increased from 177,537,775 pounds in 1927 to 178,442,704 pounds in 1928 as a result of the increase in the grade of rock produced from 1.10 per cent copper in 1927 to 1.21 per cent in 1928.

*Mine production of silver and copper in Michigan, 1921-1928*¹

Year	Silver (fine ounces)	Copper ²			Concentrate ("mineral") ³		Ore ⁴ ("rock") (short tons)
		Pounds	Yield		Pounds	Yield (per cent)	
			Pounds per ton of ore ("rock")	Percent- age			
1921 -----	310,727	86,370,028	23.9	1.19	148,024,931	58.4	3,610,648
1922 -----	376,990	121,712,365	24.6	1.23	193,984,975	62.7	4,952,264
1923 -----	223,997	138,304,080	25.8	1.29	220,055,091	62.8	5,363,160
1924 -----	130,381	135,662,005	25.3	1.26	213,779,365	63.5	5,372,572
1925 -----	139,499	155,157,488	22.0	1.10	241,056,386	64.4	7,036,751
1926 -----	105,242	175,381,565	23.0	1.15	272,365,636	64.4	7,641,682
1927 -----	97,193	177,537,775	22.1	1.10	275,460,828	64.5	8,046,334
1928 -----	17,153	178,442,704	24.2	1.21	283,405,073	63.0	7,361,658

¹ The figures are based on the actual recovery of copper from "mineral" smelted and the estimated recovery from "mineral" that was not smelted during the year.

² Includes copper from sands.

³ Includes "mineral" from sands.

⁴ Includes sands.

Value of silver and copper produced in Michigan mines, 1921-1928

Year	Silver	Copper		Total
		Total	Per ton of ore ("rock")	
1921.....	\$310,727	\$11,141,734	\$3.09	\$11,452,461
1922.....	376,990	16,431,169	3.32	16,808,159
1923.....	183,678	20,330,700	3.79	20,514,378
1924.....	87,355	17,771,801	3.31	17,859,156
1925.....	96,812	22,032,363	3.13	22,129,175
1926.....	65,671	24,553,419	3.21	24,619,090
1927.....	55,109	23,257,449	2.89	23,312,558
1928.....	10,035	25,695,749	3.49	25,705,784

The concentration process for the treatment of Michigan copper ores embodies flotation, classification, and tabling, and was developed by A. W. Fahrenwald, of the Bureau of Mines, in cooperation with the Michigan College of Mines and Technology. It was mentioned in the 1927 chapter of this series and is described more fully by Fahrenwald and Thom.³ The following is taken from their report:

The process is particularly applicable to simple ores comprising a single mineral to be recovered which is liberated wholly or to a large degree from the gangue minerals at relatively coarse comminution. In this process flotation removes all the fine and intermediate sized mineral grains. No effort is made to get flotation to make a finished tail. The flotation tail is subjected to classification, preferably of the constriction plate density control hydraulic type; however, classification of the Dorr classifier type gives good results in most cases. The classifier overflow is final tail. The classifier sand, which contains the coarse mineral grains too large and heavy to float and the true middling grains, is tabled. The table products are coarse mineral, middling, and a coarse tail. The coarse mineral generally is cleaned on a second table, and the middling is ground and returned to the initial flotation machine.

Fahrenwald flotation machines have been or are being installed at the mills of the Calumet & Hecla Consolidated Copper Co., Isle Royale Copper Co., Copper Range Co., Mohawk Mining Co., and Quincy Mining Co.

F. G. Pardee, State mine appraiser of Michigan, has published data covering the cost of copper production in Michigan in 1928. The average cost per pound for the district is given as 11.2618 cents and the average selling price as 14.7409 cents, indicating a profit of 3.4791 cents a pound for Michigan copper in 1928, compared with 1.8392 cents a pound in 1927 and 2.35 cents a pound in 1926. The details of the cost in 1928 are shown in the following statement taken from Pardee's report:

Average cost per pound of Michigan copper production in 1928

General expense:	Cents per pound
General property tax.....	0.4896
State corporation tax.....	.0451
Depreciation.....	1.3264
General office.....	.1142
Other general expense.....	.5046
	<u>2.4799</u>

³ Fahrenwald, A. W., and Thom, Clarence, Coarse Sand Flotation, Classification, and Table Concentration: Repts. of Investigations, Serial 2921, Bureau of Mines, March, 1929.

	Cents per pound
Mining cost:	
Labor	3.9608
Supplies	2.4763
	<u>6.4371</u>
Treatment cost:	
Transportation (rock to mill)	.3021
Concentrating	.8774
Transportation to smelter	.0377
Smelting and refining	.6972
	<u>1.9144</u>
Selling and delivery expense	.4304
	<u>11.2618</u>
Gross cost	
Other costs:	
Construction and installation of equipment	.5246
Income tax	.4179
Average price of copper	14.7409
Average profit	3.4791

The valuations of the copper mines as shown in Pardee's report are as follows:

Houghton County:

Calumet & Hecla Consolidated Copper Co.—

Almeek mill and railroad	\$800,000
Centennial	90,000
Calumet & Hecla conglomerate	2,500,000
Osceola	900,000
North Kearsarge	200,000
Reclamation	8,600,000
	<u>13,090,000</u>

Copper Range Co.—

Champion mine	2,750,000
Baltic mine	175,000
Trimountain	225,000
	<u>3,150,000</u>

Isle Royale Copper Co.	1,250,000
Quincy Mining Co. (including railroad)	1,000,000
Arcadian Consolidated Copper Co.	90,000
Franklin Mining Co.	100,000
Mayflower-Old Colony Copper Co.	50,000
Hancock Consolidated Copper Co.	49,000
La Salle Copper Co.	80,000
Superior Copper Co.	20,000
Winona Copper Co.	65,000
	<u>18,944,000</u>

Total, Houghton County

Keweenaw County:

Calumet & Hecla Consolidated Copper Co.—

Cliff & Phoenix	60,000
Almeek & Allouez	6,000,000
Mohawk Mining Co.	2,000,000
Seneca Copper Mining Co.	775,000
Douglass Copper Co.	40,000
	<u>8,875,000</u>

Total, Keweenaw County

Grand total, Houghton and Keweenaw Counties

Copper operations in Michigan are described in an article by Johnson.⁴

The following data are abstracted from reports by the companies to their stockholders:

The mines of the Calumet & Hecla Consolidated Copper Co. produced 91,308,000 pounds of copper at an average cost sold (not including depreciation and depletion) of 10.1 cents a pound in 1928, compared with 80,043,000 pounds at an average cost sold of 10.45 cents a pound in 1927. In addition, the reclamation plants at Lake Linden and Hubbell produced 29,896,000 pounds at an average cost sold of 5.95 cents a pound in 1928, compared with 28,717,000 pounds at an average cost sold of 6.63 cents a pound in 1927. The average price of copper delivered by the company was 14.67 cents a pound in 1928 and 13.25 cents in 1927. Operations were continuous at the Lake Linden plant and the Tamarack plant, Hubbell, Mich., and the results showed an improvement over any previous year, both as to cost and metallurgical efficiency. The combined results for the year and from the beginning of operations are shown in the following table:

	1928	Since starting
Material treated.....short tons.....	2,629,000	20,779,000
Assay headings.....per cent.....	0.666	0.669
Assay tailings.....do.....	0.094	0.146
Refined copper.....pounds.....	29,896,000	217,288,000
Refined copper per ton treated.....do.....	11.37	10.46

Of the quantity shown for 1928, 8,342,000 pounds was from table treatment following grinding, 17,174,000 pounds from leaching, and 4,380,000 pounds from flotation. The Ahmeek and Calumet mills operated at capacity, and the Lake Milling Co.'s No. 2 mill at Hubbell is in condition to treat excess rock of this company as well as rock of the Seneca Copper Mining Co. The Seneca Copper Mining Co. resumed operations in January, 1929. The Ahmeek mill is being equipped with the necessary machinery for the treatment of the copper-bearing amygdaloid tailings by flotation. The indications are that on Ahmeek rock of present grade the additional recovery will amount to about 1.1 pounds of copper per ton of rock stamped, and on the Osceola lode rock of lower grade the recovery will be somewhat less. The Calumet mill treated 813,760 tons of conglomerate rock and 262,200 tons of Osceola amygdaloid rock, and the Ahmeek mill handled 1,273,897 tons from the Kearsarge branch and 665,565 tons from the Osceola branch. The material treated at the furnace yielded 121,527,000 pounds of refined copper. The company states that after two years of preparatory work it is now ready to push vigorously the exploration program announced in its 1926 report. At that time it stated that geological studies indicated specific areas of promise, among which were those to be explored in the present Cliff and Phoenix projects. Further study has proved the wisdom of conducting these explorations. The com-

⁴ Johnson, Homar L., A Glimpse of the Michigan Copper Country with Copper at 15 Cents: Eng. and Min. Jour., Oct. 20, 1928, pp. 632-635.

pany paid dividends totaling \$5,013,755, \$2.50 a share, compared with \$4,011,004, \$2 a share, in 1927.

The Isle Royale Copper Co. treated 440,731 tons of rock in 1928, which yielded 10,520,771 pounds of refined copper, or 23.87 pounds to a ton of rock, compared with 465,100 tons of rock in 1927 and 11,391,338 pounds of refined copper, or 24.49 pounds to a ton. Three Fahrenwald machines have been installed at the Isle Royale mill and are treating the total mill product that is amenable to flotation. The additional recovery indicated on rock of present grade will amount to a maximum of 0.8 pound per ton of rock treated. This company paid three dividends totaling \$262,500 in 1928, compared with two dividends totaling \$150,000 in 1927.

The Baltic, Champion, and Trimountain mines produced 24,254,132 pounds of refined copper in 1928 at a cost sold (not including construction, depreciation, and depletion) of 11.9 cents a pound, compared with 22,661,553 pounds of refined copper at an average cost sold of 11.65 cents a pound in 1927. Of these amounts the Copper Range Co. produced 14,472,364 pounds in 1928 and 14,612,090 pounds in 1927, one-half of Champion's output belonging to St. Mary's Mineral Land Co. The rock stamped for the Baltic, Champion, and Trimountain mines yielded 43.45 pounds of copper to a ton, compared with 38.27 pounds in 1927, a notable improvement. The operating profit of the Copper Range Co. in 1928 was \$732,763.86—more than double the average of the past five years. Including lands and mineral rights acquired in 1927 and 1928, the Copper Range Co. and Champion Copper Co. own or control all the lands on the mineral formation from the Atlantic mine to the south boundary of the Globe tract, a distance of nearly 9 miles. In addition, the Copper Range Co. controls the lands $2\frac{1}{2}$ miles to the south over the upper part of the mineral formation and the St. Mary's Mineral Land Co. those carrying the lower horizons. The ownership of this territory is now sufficiently unified to permit thorough exploration. The engineering department of the Copper Range Co. cooperated with the Michigan Geological Survey in the magnetic survey of these lands; this work was followed by a rather limited geophysical survey by the Radiore Co. The information obtained gave fairly accurate data as to the strike and location of different beds or horizons, which permitted fairly accurate location of drill holes. The laboratory experiments of Fahrenwald, of the Bureau of Mines, using flotation on the Michigan ores, and mill tests of the Copper Range Co. led to a complete revision of the company's flow sheet. The new installation and the use of flotation is expected to result in a very high extraction. Dividends paid by the company totaled \$394,755, the same as in 1927.

The Mohawk Mining Co. hoisted 676,436 tons of rock in 1928 and stamped 656,739 tons, which yielded 30,002,000 pounds of mineral. The refined copper produced amounted to 21,243,265 pounds, or 32.346 pounds to a ton of ore stamped. These figures compare with 783,499 tons of rock hoisted in 1927, 759,878 tons of rock stamped, and 22,124,840 pounds of refined copper produced, or 29.116 pounds to a ton of rock stamped. The Mohawk Mining Co. has also installed flotation equipment at its mill and is experimenting with various chemicals and oils to ascertain what process is most suitable. The method indicates some reduction in tailing

losses, and the company expects to add additional flotation units. Dividends paid in 1928 totaled \$690,000 compared with \$575,000 in 1927.

Regular mining operations at the Quincy Mining Co. property were carried on only during January and February in 1928. The remainder of the year was devoted to development work in connection with the change to retreating stopes system of mining. No. 2 shaft, in which a fire occurred in 1927, is now reported to be in excellent physical condition. The installation of Fahrenwald flotation machines at the Quincy mill has resulted in an additional saving of approximately 3 pounds of copper to a ton of rock stamped. The company expects that the high percentage of recovery from the finer sands by the flotation process will enable it to re-treat at a considerable profit a large part of the 30,000,000 tons of waste sands deposited on the shore of Torch Lake since 1891. Quincy produced 1,891,200 pounds of mineral in 1928, which yielded 220,536 pounds of refined copper compared with 9,718,662 pounds of refined copper in 1927.

MISSOURI

By J. P. DUNLOP

The value of the mine production of silver, copper, lead, and zinc in Missouri in 1928 was \$24,361,227 compared with \$27,633,815 in 1927. The value of silver decreased \$29,187, that of copper \$49,721, that of lead \$2,378,172, and that of zinc \$815,508. The mine production of lead in Missouri in 1928 was equivalent to 31.2 per cent of the smelter production of primary lead from domestic ores in the United States compared with 29.7 per cent in 1927, and the mine production of zinc in Missouri was 2.2 per cent of the total primary zinc produced by smelters from domestic ores in 1928 compared with 3.2 per cent in 1927 and 22.7 per cent in 1917. About 55 mines and prospects in Missouri shipped lead or zinc concentrates in 1928.

Mine production of copper and silver in Missouri, 1919-1928

Year	Copper		Silver	
	Pounds	Value	Fine ounces	Value
1919.....	1,617,200	\$300,799	90,401	\$101,249
1920.....	1,512,539	278,307	111,128	121,130
1921.....	137,591	17,749	69,902	69,902
1922.....	797,400	107,649	212,656	212,656
1923.....	202,556	29,776	177,270	145,361
1924.....	182,811	23,948	103,694	69,475
1925.....	12,100	1,718	83,340	57,838
1926.....	1,077,000	150,780	90,000	56,160
1927.....	451,000	59,081	233,931	132,638
1928.....	65,000	9,360	176,840	103,451

The silver content of the lead ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied on for the silver production. The

quantity of silver produced in any year bears no direct ratio to the quantity of lead concentrates smelted during that year, because the silver content is so small that the silver bullion is stored and refined in batches. Over a series of years the concentrates average about 1 ounce of silver to the ton.

All of the copper produced in 1928 was derived from matte recovered in smelting lead ores; some development was done at copper mines, but no copper ore was shipped in 1928.

The value of the lead and zinc from concentrates produced in Missouri in 1928 was \$24,248,416, a decrease of \$3,193,680 from the value for 1927. The production of lead concentrates (of which only 164 tons was lead carbonate) was 276,502 tons, as compared with 282,847 tons in 1927. Of the total output in 1928, 274,925 tons was derived from central and southeastern Missouri, a decrease of 4,516 tons. The average lead content of the galena concentrates from these districts was 72.1 per cent in 1928, and the value of the galena concentrates per ton in 1928 was \$69.50, as compared with \$83.60 in 1927. The lead derived from galena concentrates in central and southeastern Missouri in 1928 was 194,270 tons, a decrease of 1,981 tons.

Shipments of galena concentrates from southwestern Missouri in 1928 were 1,413 tons, compared with 3,106 tons in 1927; the decrease was due to the closing of the Log Cabin mine near Duenweg. The lead carbonate concentrates in 1928 amounted to 164 tons, a decrease of 136 tons. The quantity of lead recovered from concentrates from southwestern Missouri was 1,123 tons, a decrease of 1,386 tons. The average lead content of the galena concentrates from southwestern Missouri in 1928 was 74.2 per cent, and the average value of the galena concentrates per ton was \$75.16, or \$8.10 less than in 1927.

The total quantity of sphalerite concentrates from Missouri mines in 1928 was 23,994 tons, a decrease of 11,681 tons compared with 1927, and 17,397 tons of the total came from southwestern Missouri. It sold for an average price of \$38.38 a ton and had an average zinc content of 59.9 per cent, compared with an average price of \$40.08 and an average assay of 58.3 per cent in 1927. The shipments of sphalerite concentrates from southeastern Missouri were 6,597 tons of 59.5 per cent concentrates. These will increase with the extension of flotation plants and new mills in certain parts of the mining area.

The zinc carbonate and silicate concentrates sold in 1928 amounted to 987 tons, or 370 tons less than in 1927. The output came entirely from southwestern Missouri. The average zinc content of these concentrates was 39.5 per cent, and the average value per ton was \$20.97, compared with 38.2 per cent and \$26.26 in 1927.

The value of the galena concentrates from central and southeastern Missouri (which produced 99 per cent of the total for the State) was \$19,107,891, or \$4,252,403 less than in 1927, and the value of the sphalerite concentrates was \$236,111, or \$53,705 less than in 1927. The total value of the lead and zinc concentrates shipped from southwestern Missouri was \$804,411, compared with \$1,405,694 in 1927.

The total quantity of ore and tailings treated in Missouri in 1928 was 6,573,800 tons. The total amount received for all classes of lead and zinc concentrates sold in 1928 was \$20,148,413, an average of

\$3.06 to the ton of ore and tailings treated, or 61 cents less than in 1927.

In the following tables, showing the tenor of ore ("dirt") and concentrates from Missouri, it has been considered advisable to segregate ores of different nature. The disseminated lead ore of southeastern Missouri differs radically from the lead and zinc ores of the so-called "soft-ground" deposits of southwestern Missouri. Each class of ore has its peculiar problems of mining and ore dressing. The data are given for the ores mined in the Joplin region, but there have been no recoveries from "sheet ground" since 1921. In general, the tables reflect very closely the conditions of the industry.

Mine production of lead and zinc in Missouri in 1928, by districts

District	Lead concentrates				Zinc concentrates			
	Galena		Carbonate		Sphalerite		Silicate and carbonate	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Aurora.....			63	\$3,800				
Ouenweg-Porto Rico.....	24	\$1,963	1	61			300	\$6,356
Granby.....	151	10,260					130	2,742
Greene County.....	15	1,200						
Joplin.....	684	53,248	100	5,979	2,958	\$109,550	93	2,255
Oronogo.....	161	10,702			5	127	1	18
Smithfield-Thoms Station.....	46	3,609			10,237	405,866		
Spring City-Spurgeon.....	120	9,065					463	9,322
Waco.....	62	4,486			3,084	113,699		
Webb City-Carterville-Prosperity.....								
Wentworth.....	150	11,572			140	3,868		
					973	34,663		
Central and southeastern Missouri.....	1,413	106,105	164	9,840	17,397	667,773	987	20,693
	274,925	19,107,891			6,597	236,111		
Total, 1927.....	276,338	19,213,996	164	9,840	23,994	903,884	987	20,693
	282,547	23,618,893	300	18,000	35,675	1,383,279	1,357	35,632

District	Metal content ¹			
	Lead		Zinc	
	Short tons	Value	Short tons	Value
Aurora.....	38	\$4,408		
Ouenweg-Porto Rico.....	18	2,088	103	\$12,566
Granby.....	103	11,948	46	5,612
Greene County.....	12	1,392		
Joplin.....	569	66,004	1,572	191,784
Oronogo.....	107	12,412	3	366
Smithfield-Thoms Station.....	34	3,944	5,467	666,974
Spring City-Spurgeon.....	88	10,208	163	19,886
Waco.....	42	4,872	1,637	199,714
Webb City-Carterville-Prosperity.....			62	7,564
Wentworth.....	112	12,992	464	56,608
Central and southeastern Missouri.....	1,123	130,268	9,517	1,161,074
	194,270	22,535,320	3,457	421,754
Total, 1927.....	195,393	22,665,588	12,974	1,582,828
	198,760	25,043,760	18,737	2,398,336

¹ In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and concentrates produced in southwestern Missouri, 1925-1928

	1925	1926	1927	1928
Total ore.....short tons..	662,200	1,025,500	513,800	281,300
Total concentrates in ore:				
Lead.....per cent..	0.54	0.52	0.66	0.56
Zinc.....do.....	4.30	4.76	5.57	5.47
Metal content of ore:				
Lead.....do.....	0.41	0.39	0.50	0.41
Zinc.....do.....	2.54	2.77	3.21	3.23
Average lead content of galena concentrates.....do.....	76.8	76.8	76.5	74.2
Average lead content of lead carbonate concentrates.....do.....	60.0	60.0	60.0	59.1
Average zinc content of sphalerite concentrates.....do.....	60.8	59.6	58.3	59.9
Average zinc content of silicates and carbonates.....do.....	38.2	39.3	38.2	39.5
Average value per ton:				
Galena concentrates.....	\$110.51	\$105.74	\$83.26	\$75.16
Lead carbonate concentrates.....	\$55.73	\$78.87	\$60.00	\$60.00
Sphalerite concentrates.....	\$54.18	\$49.01	\$40.08	\$38.38
Zinc silicates and carbonates.....	\$30.80	\$31.61	\$26.26	\$20.97

Tenor of lead ore and concentrates in southeastern Missouri disseminated-lead district, 1925-1928

	1925	1926	1927	1928
Total lead ore.....short tons..	6,209,800	6,261,600	6,310,200	6,292,500
Galena concentrates in ore.....per cent..	5.06	4.80	4.42	4.37
Lead content of ore.....do.....	3.43	3.32	3.17	3.17
Average lead content of galena concentrates.....do.....	67.6	69.0	71.7	72.1
Average value per ton of galena concentrates.....	\$100.91	\$93.98	\$83.62	\$69.50

Mineral Resources for 1914, Part I, pages 72 to 77 and 97 to 100, gave a brief history of lead and zinc mining in the southeastern Missouri and Joplin regions, as well as data relating to the total lead and zinc production, the mining and milling practice, the character of the ore and concentrates, and the methods of selling them.

SOUTHWESTERN MISSOURI

Area and production.—The southwestern Missouri lead and zinc areas include the largest part of the Joplin region, the remainder lying in southeastern Kansas and northeastern Oklahoma.

Lead and zinc concentrates produced in the Missouri part of the Joplin region, 1907-1928

	Short tons	Value	
		Total	Average
Lead concentrates.....	460,716	\$29,802,335	\$64.69
Sphalerite concentrates.....	2,914,914	147,891,915	50.74
Zinc carbonate and silicate concentrates.....	304,790	9,416,288	30.89
	3,680,420	187,110,538	-----

Prices.—The following quoted base prices apply not only to southwestern Missouri but also to all the mines in Oklahoma and Kansas that are in the Joplin region, except that small scattered lots of concentrates of less than a carload bring a slightly lower price.

The high-grade sphalerite containing less than 0.20 per cent of lead, of which there were about 75,000 to 80,000 tons in 1928, brought during most of 1928 about \$1 premium above the base price. Considerably less flotation sphalerite concentrates were mixed with jig and table concentrates than in 1927, as stocks at mines were large and smelters did not desire the mixed concentrate. The all-flotation zinc concentrates containing above 55 per cent of zinc brought \$3 a ton less than base price; lower grades were subject to higher penalties. With a base price of \$40 a flotation concentrate of 55 per cent with a low iron content brought \$32 a ton. The demand for mixed table and flotation concentrates was poor during most of 1928, and a large part of accumulated stocks at mines was of this mixed character. The striking features of the market for sphalerite were that the base price per ton varied only \$5 during the year and that the price remained stable at \$40 from May 10 to the end of the year. The highest base price in 1928 for 60 per cent sphalerite was \$40, and the lowest was \$35. The quoted price the first week in January was \$36, advancing to \$38 at the end of the month. The February base prices were \$35 and \$36. In March the price advanced to \$40 for one week, then slumped to \$38, where it remained during April. The opening May price was \$39, soon advancing to \$40 and remaining at that price for the rest of 1928.

No base prices were quoted for zinc silicate in 1928, and there was no demand for hand-cobbed ore. The output of milled zinc silicate was less than in 1927, and the small quantity available materially affected the demand, which picked up in the fall. The main shippers of zinc silicate were small Granby lessees, the Joplin Mining Co. of Duenweg, and the St. Charles Mining Co. near Spring City.

In 1928 the prices quoted for galena carrying 80 per cent of lead showed a variation of \$12.50 a ton, compared with \$25 a ton in 1927. The quoted price for January was \$85 a ton, declining to \$77.50 in February and to \$72.50, the lowest quotation of the year, in March. The April and May price was \$77.50 and the June price \$82.50. The price declined to \$80 late in July, then remained stable to the end of August. During the first week in September the price advanced to \$82.50 and the third week in September to \$85, a price that prevailed until the end of 1928.

Average prices per ton paid for sphalerite, and zinc and lead concentrates in southwestern Missouri, 1920-1928

	1920	1921	1922	1923	1924	1925	1926	1927	1928
Sphalerite.....	\$45.79	\$25.18	\$31.91	\$40.52	\$41.91	\$54.18	\$49.01	\$40.08	\$38.38
Zinc silicate or carbonate concentrates.....	35.50	10.57	21.25	26.57	24.29	30.80	31.61	26.26	20.97
Galena concentrates.....	97.84	50.15	69.44	83.40	101.31	110.51	105.74	83.26	75.16

General conditions.—Only about 16 mills were operated in southwestern Missouri in 1928, and most of these were not operated continuously. The number of gougers and small lessees was less than for many years, and less than half as much drilling was done as in

1927. A considerable number of mines and mills were abandoned, and some large mines were idle all the year. The purchase of fee lands by companies and individuals continued. The lands were purchased for future operations and the fees acquired so that there would be no obligation to drill, construct mills, or open mines. The successful use of the picking belt and a small increase in prices may result in the profitable mining of a considerable part of the old sheet-ground area. There was no mining in 1928 in the Alba-Neck City, Carl Junction, Racine, and Webb City camps in 1928. Work at Granby, Oronogo, and Spurgeon was confined to scrapping. In southwestern Missouri there was a decrease of 1,693 tons of galena, 9,888 tons of sphalerite, and 370 tons of zinc silicate, and from present indications there will be another decrease in 1929.

The Smithfield-Thoms Station area produced 59 per cent of the sphalerite shipped in 1928, and the Isherwood property of Kansas Explorations (Inc.) was much the largest shipper of sphalerite. Several shafts supplied ore to the 250-ton mill, which produced the highest grade zinc concentrates in the district. The Octagon mine at Smithfield was a small producer of high-grade sphalerite. The Grasselli mine and mill at Thoms Station was closed in February, 1928. The Four Corners Mining Co. started operations late in 1928 and shipped some sphalerite. Mines in the Missouri part of the Waco district produced much less concentrate than in 1927. The largest output was from the Barnsdall mine operated by the Missouri Kansas Zinc Corporation; the other shippers were the Missouri Mining Co. and the Universal Exploration Co. The Universal was unwatered and operated in the spring of 1928.

The Joalmo, owned by the Joplin Mining Co., was the only mill operated in 1928 at Duenweg. It was reopened, a new shaft was sunk, and new derricks, hoister, and tramway were built. The output of the American Zinc, Lead & Smelting Co. lands at Granby, Oronogo, Spurgeon, and Webb City was all made by small lessees; no mills were run.

There was considerable leasing and drilling at Aurora late in 1928 and, although the output was very small, several mills were being built; these included the Barbo mill (200 tons) and the New Field Mining Co.'s mill (150 tons). The Barbo mill was operated at Wentworth until the fall of 1928, when it was torn down and rebuilt to provide milling facilities to the lessees of 1,000 acres of land at Aurora. The St. Charles Mining Co. operated the only mill in the Spring City-Spurgeon camp; considerable galena and zinc silicate were shipped. Mines near Joplin shipped 2,958 tons of sphalerite and more than 600 tons of galena in 1928. The Admiralty Zinc Co. was the largest producer; its mill ran part of the year, but operations were unprofitable, so it was closed down. Much of the lead shipped from the Joplin camp and considerable sphalerite were produced by the White Shirt Mining Co.'s 100-ton mill on Connor land. The Riverside mine near Fillmore's bridge was operated on a small scale most of the year, and both galena and sphalerite were shipped. The mill was burned in 1929. Smaller shipments of galena, sphalerite, and zinc silicate were made by the

Ruby C Mining Co. (Connor land). A 75-ton mill was built on the Connor land in 1928 by the Joe Bob tailing mill and by the Buxton-Durfee custom mill.

CENTRAL AND SOUTHEASTERN MISSOURI

A brief description of the ore deposits in central and southeastern Missouri is given in the chapter of this series for 1915.

Copper, silver, nickel, and cobalt occur in the ore in considerable quantity near Fredericktown and in small quantity irregularly in nearly all the deep mines of this region. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district.

In the disseminated-ore district the production increased rapidly after 1869 and is estimated by Buckley to have amounted to 1,202,607 tons of lead concentrates, valued at \$59,869,354, for the period from 1869 to 1906, inclusive. The mine production of southeastern and central Missouri has been reported annually since 1907.

Mine production of lead and zinc concentrates in southeastern and central Missouri, 1907-1928

Year	Lead concentrates (galena)		Zinc concentrates			
			Sphalerite		Carbonate and silicate	
	Short tons	Value	Short tons	Value	Short tons	Value
1907-1918.....	2, 831, 000	\$156, 506, 767	1, 016	\$44, 137	9, 993	\$225, 048
1919.....	229, 687	11, 590, 977			231	6, 576
1920.....	242, 248	19, 799, 389			61	1, 910
1921.....	280, 358	11, 737, 400				
1922.....	271, 294	14, 779, 869				
1923.....	259, 320	19, 434, 633				
1924.....	292, 604	24, 739, 819				
1925.....	314, 403	31, 727, 170				
1926.....	300, 480	28, 239, 733	2, 301	101, 243		
1927.....	279, 441	23, 360, 294	8, 390	289, 816		
1928.....	274, 925	19, 107, 891	6, 597	236, 111		

The output of silver in Missouri in 1928 was derived from refining pig lead or from copper matte or zinc concentrates recovered in milling or smelting lead ores.

The lead ore mined in the disseminated-lead district in 1928, amounting to 6,292,500 tons, yielded 4.37 per cent of lead concentrates which averaged 72.1 per cent of lead. The average value per ton of lead concentrates was \$69.50, compared with \$83.62 in 1927; the output of galena concentrates was about 274,900 tons, compared with 279,042 tons in 1927. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are to a certain extent arbitrary. The galena concentrates produced in the southwestern Missouri region, which usually contain a higher lead content, are sold mainly on bids from

purchasers, and the values for those concentrates are not comparable with values given for concentrates of the disseminated-lead district.

Analyses of ores mined in the disseminated-lead district in southeastern Missouri and of the various grades of resulting concentrates are given in Mineral Resources for 1919 and 1920.

There were no shipments of zinc carbonate from southeastern Missouri during 1928, but there was an output of sphalerite from the flotation plant of the St. Joseph Lead Co. Large quantities of zinc middlings from old operations are available for treatment at other plants in the future, and in some mines the quantity of zinc contained in the lead ore is greater than in ores formerly mined. Flotation will result in the recovery of much of this zinc; in consequence shipments of zinc concentrates from southeastern Missouri are sure to increase. An average assay of the sphalerite concentrates shipped in 1928 was 59.5 per cent of zinc and 20 ounces of silver a ton. A more detailed average assay of the sphalerite concentrates shipped in 1927 is as follows: Zinc, 57.5 per cent; copper, 0.1 per cent; iron, 2 per cent; calcium oxide, 1.3 per cent; magnesium oxide, 1 per cent; sulphur, 32 per cent; lead, 3 per cent; cadmium, 1 per cent; carbon dioxide, 2 per cent; and silver, 20 ounces a ton.

Only 23 tons of galena concentrates were recovered in 1928 from shallow diggings; it was shipped by T. F. Blount, of Potosi, and by lessees of the Washington Land & Mining Co. The Conqueror Lead Co. shipped some lead in December, 1928. All the rest of the lead was produced by the Annapolis Lead Co., the Desloge Consolidated Lead Co., the National Lead Co. (St. Louis), and the St. Joseph Lead Co.

The copper was derived from the treatment of copper-lead matte shipped to smelters, as no copper ore was treated in 1928.

The Desloge Consolidated Lead Co. operated three shafts in 1928 and increased its output of ore. Shaft No. 6 was electrified, and the differential flotation plant and 4,000-horsepower turbo-generator were placed in operation. The new plant will produce some sphalerite concentrates.

The Annapolis Lead Co. in Iron County worked its mine and mill steadily in 1928, milling about 200,000 tons of ore.

The Conqueror Lead Co. bought the Katherine mine and did some drilling and development work. The company erected a 300-ton flotation plant and operated it on tailings late in 1928.

In 1928 the St. Joseph Lead Co., from mines in southeastern Missouri, treated about 4,379,000 tons of ore, which yielded 202,800 tons of galena concentrates. It also shipped about 6,500 tons of sphalerite concentrates. The company operated four concentrating plants having a total capacity of 15,300 tons daily. The plants are equipped with Wilfley and Butchart tables and flotation machines. A new mill was under construction at the Mine La Motte at Fredericktown. The 19 shafts in operation ranged in depth from 200 to 500 feet.

The National Lead Co. operated five shafts (average depth, 525 feet) and a concentrating plant (capacity, 3,500 tons) equipped with flotation machines.

OKLAHOMA

By J. P. DUNLOP

Mine production of lead and zinc in Oklahoma in 1928, by districts

District	Lead concentrates (galena)		Zinc concentrates (sphalerite)		Metal content ¹			
					Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Miami.....	52,473	\$4,244,132	327,490	\$11,878,417	40,369	\$4,682,804	166,663	\$20,332,886
Quapaw and Sunnyside...	4,366	347,843	26,581	974,380	3,318	384,888	13,589	1,657,858
	56,839	4,591,975	354,071	12,852,797	43,687	5,067,692	180,252	21,990,744
Total, 1927.....	67,444	5,852,023	404,228	15,475,966	51,680	6,511,680	206,611	26,446,208

¹ In calculating the metal content of the ores from assays allowance has been made for smelting losses of both lead and zinc. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore, old tailings, and slimes milled and concentrates produced in Oklahoma, 1927-28

	1927		1928	
	Crude ore	Old tailings and slimes	Crude ore	Old tailings and slimes
Total ore, etc., milled.....short tons..	7,199,100	2,733,300	5,527,700	2,500,300
Total concentrates recovered:				
Galena.....do.....	67,076	368	56,449	390
Sphalerite.....do.....	356,415	47,793	315,717	38,354
Ratio of concentrates to ore, etc.:				
Lead.....per cent.....	0.93	0.01	0.87	0.01
Zinc.....do.....	4.95	1.75	5.55	1.53
Metal content of ore, etc.:				
Lead.....do.....	0.73	0.01	0.69	0.01
Zinc.....do.....	2.89	0.97	3.21	0.88
Average lead content of galena concentrates.....do.....	78.2	68.0	78.5	66.2
Average zinc content of sphalerite concentrates.....do.....	58.5	55.5	57.9	57.1
Average value per ton:				
Galena concentrates.....	\$86.87	\$68.58	\$80.87	\$68.25
Sphalerite concentrates.....	\$38.93	\$33.47	\$36.72	\$33.39

The following table gives the output of lead and zinc ore, old tailings, etc., for Oklahoma from 1925 to 1928:

Tenor of lead and zinc ore, old tailings, and slimes milled and concentrates produced in Oklahoma, 1925-1928

	1925	1926	1927	1928
Total ore, old tailings, and slimes milled in Oklahoma.....short tons.....	10,605,200	10,934,000	9,932,400	8,028,000
Total concentrates in ore, etc.:				
Lead.....per cent.....	1.01	0.86	0.68	0.61
Zinc.....do.....	5.13	4.95	4.07	4.30
Metal content of ore, etc.:				
Lead.....do.....	0.80	0.65	0.53	0.68
Zinc.....do.....	3.01	2.83	2.36	2.49
Average lead content of galena concentrates.....do.....	78.9	78.5	78.2	78.4
Average zinc content of sphalerite concentrates.....do.....	58.6	58.1	58.1	57.8
Average value per ton:				
Galena concentrates.....	\$117.13	\$106.95	\$86.77	\$80.79
Sphalerite concentrates.....	\$50.64	\$45.91	\$38.29	\$36.30

Mine production of lead and zinc concentrates in Oklahoma, 1891-1928, by districts

District	Lead concentrates (mainly galena)		Zinc concentrates			
	Short tons	Value	Sphalerite		Zinc silicate and carbonate	
			Short tons	Value	Short tons	Value
Davis.....			558	\$27,399	899	\$24,592
Miami.....	918,241	\$82,273,857	4,683,986	200,772,327		
Peoria.....	2,206	109,163	220	8,289	2,944	76,787
Quapaw and Sunnyside.....	22,248	2,035,016	162,351	7,058,124	164	2,692
	942,695	84,418,036	4,847,115	207,866,139	4,007	104,071

Mineral Resources for 1914 contains a brief history of mining in the districts in Oklahoma and also the estimated total production of each district, by years.

The total quantity of lead and zinc concentrates shipped from Oklahoma in 1928 was 13 per cent less than in 1927, and the total value was 18 per cent less. The total value of the zinc concentrates was \$2,623,169 less than in 1927 but greater than the value of any one year's production of any other State.

The lead and zinc deposits of northeastern Oklahoma, so far as known, are confined to Ottawa County and form the southwestern extension of the deposits in the Joplin region. There are three camps—Peoria, Quapaw-Sunnyside, and Miami—in which extensive mining has been done, and a fourth, the Sycamore Creek district, along the Seneca fault block 2 to 3 miles southwest of Seneca, Mo., in which considerable prospecting has been done and some ore mined. The lead and zinc deposits in southern Oklahoma are near Ravia, at the southeast end of the Arbuckle Mountains, and near Davis, Murray County, at the northwest end of the same range.

The quantity of ore and old tailings milled in Oklahoma decreased 1,904,400 tons in 1928, of which the total quantity milled at mines near Quapaw and Sunnyside (all mills at Commerce were idle) was less than 5 per cent, compared with 1 per cent in 1927. The value of the lead and zinc shipped from mines in Oklahoma in 1928 was \$27,058,436, compared with \$32,957,888 in 1927. The lead from concentrates sold decreased from 51,680 to 43,687 tons and the zinc from 206,611 to 180,252 tons.

The average lead content of the galena concentrates shipped increased from 78.2 per cent in 1927 to 78.4 per cent in 1928. The average metal content of the sphalerite concentrates shipped was 57.8 per cent, compared with 58.1 per cent in 1927.

Oklahoma produced 62 per cent of the total output of both lead and zinc concentrates from the Joplin region in 1928. The Oklahoma shipments of sphalerite decreased 50,157 tons.

A history of the mining in the Miami district, including the output by years for 1908 to 1914 and the location of the mines and mills, was given in Mineral Resources for 1914. The reports for 1915 to 1927 contain full reviews of the production, new territory prospected, new mines opened, and new mills erected in those years.

A brief description of the ore deposits in the Miami district is given in Mineral Resources for 1915.⁵

In 1928 about 110 mills in the Oklahoma part of the Joplin region shipped 56,839 tons of galena concentrates and 354,071 tons of sphalerite concentrates. The average value of the galena concentrates decreased \$5.98 a ton, and the average value of sphalerite concentrates, of which the quantity was nearly six times as great as that of galena shipped, decreased \$1.99 a ton.

One significant feature of the year was the long period (more than six months) during which the quoted price of sphalerite concentrates of ordinary grade remained at \$40 a ton.

Efforts were made to curtail the output of sphalerite to the requirements of retort smelters, but not until December were stocks at mines cut about 20,000 tons by a spurt of buying by smelters. Improvements in the flotation process at the mills resulted in a larger output of higher grade flotation zinc concentrates. All the larger mills are now equipped with flotation, and the output from this source in 1928 in Oklahoma was 2,744 tons of galena and 69,860 tons of sphalerite. About 5 per cent of the total output of galena and about 20 per cent of the sphalerite were flotation products. No stated reduction from the base price was exacted for galena flotation concentrates sold, but the zinc flotation concentrates were subject to a \$3 penalty compared with the jig and table concentrates of equal zinc content. A large part of the sphalerite in bins at mills at the end of 1928 was a mixed flotation and jig product. The quantity of old tailings and slimes treated decreased from 2,733,300 tons in 1927 to 2,500,300 tons in 1928. The percentage of recovery of sphalerite in concentrates from tailings decreased from 1.75 per cent to 1.53 per cent, probably owing to the smaller quantity of rich slimes treated. The average assay of the sphalerite concentrates from tailings increased from 55.5 per cent in 1927 to 57.1 in 1928. The treatment of tailings in this field conclusively shows that the tailings, regardless of the richness of the original crude ore, contain very little recoverable galena, and that the small recovery of galena at nearly all plants is a low-grade product.

Improvements were made at a considerable number of mines and mills, but few new mills were built and costs were cut to a minimum. There was an excess of production, so development was retarded wherever possible. The number of drill rigs in operation was less than 50 per cent of the number employed in former years. Labor was abundant, and there was even an excess at times due to temporary curtailment in order to reduce the surplus ore in mine bins. Spasmodic operations are not conducive to low costs; a determined effort, however, was made to reduce rock ton costs, and this effort met with moderate success. It is doubtful if the mills treating tailings made much profit at an average recovery of 1.53 per cent and an average price of \$33.39 received for sphalerite concentrates.

The total quantity of ore and tailings milled in the Miami part of the Joplin region in Oklahoma and Kansas in 1928 was 12,690,200 tons, and the shipments were 87,238 tons of galena concentrates and 527,495 tons of sphalerite concentrates. Of this 4,434 tons of galena

⁵ Siebenthal, C. E., Zinc: Mineral Resources of the United States, 1915, Part I, pp. 888-890.

and 104,800 tons of sphalerite were flotation concentrates. Each of 93 mines in this region made shipments of galena and sphalerite concentrates exceeding \$100,000 in value. As in 1927, more shafts and mills were in operation in this small area than in any other district in the United States. Some of the sphalerite recovered by flotation assayed 60 per cent of zinc, some as low as 45 per cent, but the great bulk 55 to 58 per cent. Not many mines in the Miami field were abandoned in 1928, although a number of the older properties were cleaning up and pulling pillars, and some mills were operating partly on ore and partly on old tailings. Consolidation of properties and larger unit mills constantly tend to reduce the number of active concentrating plants.

The quantity of ore, old tailings, and slimes milled in Oklahoma decreased from 9,932,400 tons in 1927 to 8,028,000 tons in 1928. The average zinc content of the sphalerite was 51.8 per cent in 1912, 58.6 per cent in 1925, and, owing to the increased quantity of concentrates from tailings, 57.8 per cent in 1928. The separate assays reported in 1928 showed a range in zinc content from 45 to 62 per cent, but most of the sphalerite assayed between 57 and 59 per cent. An assay of a composite sample of 9,020 lots of concentrates shipped in 1928 from the Miami region in Oklahoma and Kansas showed an average content of 57.65 per cent of zinc, 2.45 per cent of iron, 0.51 per cent of lead, and 0.51 per cent of cadmium; the average zinc assay, as computed from the reports of all the companies selling concentrates, was 57.8 per cent of zinc.

The recovery of concentrates from all the mines in Oklahoma averaged 1 ton of galena to 7 tons of sphalerite. The proportion of galena concentrates recovered from crude ore varied widely in different mines and in different parts of the same mine, ranging from less than 1 ton of galena to 200 tons of sphalerite to 3 tons of galena to 1 ton of sphalerite.

The total shipments from those properties that may be classed as in the Cardin-Douthat area, of which there were a greater number than in the other areas, amounted to 29,684 tons of galena and 189,789 tons of sphalerite. The percentage of concentrates recovered increased from 4.69 to 5 per cent, and the quantity of concentrates shipped decreased 48,796 tons. About 4,277,000 tons of ore and tailings were milled, and the recovery in concentrates averaged about 0.60 per cent for galena and 4.4 per cent for sphalerite. The ratio of galena to sphalerite recovered at all mines in the vicinity of Douthat was 1 ton of galena to about 13 tons of sphalerite, in the Cardin section it was 1 ton of galena to about 6 tons of sphalerite, and in the Picher area 1 ton of galena to about 5 tons of sphalerite.

The territory east of Picher near the Hockerville and Zincville camps was more productive than in 1927, when the shipments from 24 mines and 4 tailing mills were 5,546 tons of galena and 54,835 tons of sphalerite; in 1928 the shipments from 16 mines and 3 tailing mills were 6,749 tons of galena and 60,006 tons of sphalerite from 996,400 tons of ore and 122,300 tons of old tailings and slimes treated. The sphalerite averaged about 59 per cent in zinc content and the galena 77.3 per cent in lead content.

The production of the mines near Picher decreased. In 1927 the quantity of ore and old tailings milled was 2,461,300 tons, and the

shipments were 16,672 tons of galena and 88,969 tons of sphalerite. In 1928 the quantity of ore and old tailings milled was 2,261,000 tons, and the shipments were 15,705 tons of galena and 77,695 tons of sphalerite. The decrease in average recovery was due to the large increase in the quantity of tailings milled (910,700 tons). The zinc content of the sphalerite averaged 58.2 per cent and the lead content of the galena 78.4 per cent.

At Commerce (old Hattenville) none of the old mines—such as the Cactus, Emma Gordon, Lost Trail, McBee, and Turkey Fat—were operated in 1928, and the only shipments were of galena milled in 1927.

No shipments were reported from Peoria in 1928, the oldest mining camp in the State, and little work was done.

Near Hockerville and Zincville.—The Brewster mine, one of the oldest in the district, was again the largest producer in this area; the Atzec mine ranked second. Other leading producers were the Beck, Blue Bonnett, Duluth, Farmington, Huttig No. 1, Imbau, Indiana (tailings), Lucky Jenny, Mary Ann, Retriever (tailings), Royal, Semple (tailings), Texas, Wade, and Weiss. The tailing mills treated about 122,000 tons of tailings and slimes. The Dorothy Bill Mining Co. added the Dobson east 40 acres to its holdings. A flotation plant was built at the Mary Ann, and other improvements were made in 1928; the property has since been purchased by the Commerce Mining & Royalty Co. The Texas mine was worked by the Dumarks Mining Co. in 1928 but has since been purchased by the Advance mine. The Santa Fe mine was idle in 1928 and is now being operated by F. C. Murphy and associates. E. Y. Semple purchased the Brightley tailing plant, and the Crystal Mining Co. purchased the Wade mine.

Near Quapaw and Sunnyside.—In this area about 371,000 tons of ore was milled in 1928, yielding 4,366 tons of galena concentrates and 26,581 tons of sphalerite concentrates. More than 65 per cent of the galena came from the Malsbury mine; several properties yielded no appreciable quantity of galena. Three mines of the Century Zinc Co. produced about 98 per cent of the galena and 70 per cent of the sphalerite. Most of the remainder was the output of the Donna Jane Mining Co., the Pearl Mining Co., and the Tulsa Lead & Zinc Co. The Davenport mill of the Federal Mining & Smelting Co. was idle all 1928 and the Hobart mine was idle until December, when it was purchased and run by the Ilhawa Mining Co. The Patty C. mine was bought and operated part of the year by the Pearl Mining Co., and the Donna Jane mine was worked by F. W. Evans. The old Rainbow mine and mill were idle in 1928 and were sold to the Hanenkratt Lead & Zinc Co. The Bingham mill of the Century Zinc Co. was dismantled late in 1928.

Near Century and Douthat.—More than half of the sphalerite concentrates shipped from properties in this area was sold by the Admiralty Zinc Co. and the Skelton Lead & Zinc Co., and 60 per cent of the galena concentrates was shipped by the New Chicago Mines Corporation and the Skelton Lead & Zinc Co. Other producing properties were the Childress Lead & Zinc Co., Consolidated Lead & Zinc Co., and Ramage Mining Co. Tailing mills active and shipping in 1928 were those of Andrew Bros. (old Dudley), Century Milling Co., and Moyer Milling Co. Old tailings were

also run at New Chicago mills and by Skelton Lead & Zinc Co. The quantity of old tailings and slimes reported as treated in 1928 was 324,900 tons, and the recovery was 6,375 tons of sphalerite and 110 tons of galena.

Near Cardin and Tar River.—This area in the Miami field had the largest number of operated mines and mills and made the largest shipments of concentrates in 1928. The leading shippers were the Anna Beaver Mine Co. (2 mills), Commerce Mining & Royalty Co. (6 mills), Evans Wallower Lead Co. (3 mills), Federal Mining & Smelting Co. (2 mills), Interstate Zinc & Lead Co., Rialto Mining Corporation, and the Velie Mine Corporation.

Other large producers of lead and zinc were the American Zinc, Lead & Smelting Co., Childress & Heggen Mining Co., Childress Lead & Zinc Co., Consolidated Lead & Zinc Co., Crystal Mineral Trust, Foch Mining Co., L. & G. Mining Co., Pioneer Lead & Zinc Co., Quapaw Mining Corporation (Tom L.), and Tri State Mining Co.

The output of sphalerite concentrates from tailings was made at mills operated by the Canadian Mining & Development Co., Childress & Heggen Mining Co. (Chapman), Childress Lead & Zinc Co. (Southside), Commerce Mining & Royalty Co. (Gosling and Standard), Consolidated Lead & Zinc Co. (No. 13), Federal Mining & Smelting Co. (Lucky Bill), Kansas Explorations (Inc.) (Ritz), L. & G. Mining Co., and O. M. Bilharz Mining Co.

The total quantity of slimes and old tailings treated in 1928 was 1,142,400 tons, and the shipments of concentrates from this source were 201 tons of galena, averaging 65 per cent lead content, and 17,398 tons of sphalerite, averaging about 57 per cent zinc content. The quantity of tailings treated in 1928 was about 200,000 tons more than in 1927, and the recovery of concentrates was about 337 tons less than in 1927. The Canadian Mining & Development Co. sold the Dorothy Bill tailing mill to the Roberts Milling Co. in June, 1927. All of the mines, mills, and leases of the Golden Rod Mining & Smelting Co. in Oklahoma and Kansas were transferred to the Evans Wallower Lead Co., and a 100-ton electrolytic zinc plant is being built at St. Louis, Mo. The Canam Metals Corporation obtained an option on all Childress Lead & Zinc Co. properties in the Miami field in 1928 and in 1929 exercised this option and took over the Fort Worth, Fox, Southside, and Whitebird mines. The company has also acquired the Foch, Mineral Trust, and Tri State mines in the Cardin area. The Velie Mine Corporation purchased the Harrisburg mine, south of its Lion mine; the Harrisburg was idle in 1928. Considerable development work was done on the Bird Dog lease; a large mill will be built by the Commerce Mining & Royalty Co. in 1929.

Near Picher.—From the area about Picher, which includes many of the older mines of the Miami district, the output of concentrates and the quantity of ore milled in 1928 were considerably less than in 1927, although the quantity of tailings treated increased 250,000 tons. The largest shipper in 1928 was the Eagle-Picher Lead Co. (6 mills). Other large shippers were the American Zinc, Lead & Smelting Co. (Big Chief), Birthday Mining Co. (Leonora), Childress Lead & Zinc Co. (Whitebird), Commerce Mining & Royalty Co. (Grace Walker), Commonwealth Mining Co., Consolidated Lead & Zinc

Co., Cortez King Brand Mining Co. (New York 1 and 2), Federal Mining & Smelting Co. (Gordon), Golden Hawk Mining Co., Howe Mining Co., Jeff City Mining Co., Mahutska Mining Co., New Chicago Mines Corporation (2 mills), and Tri State Zinc Co.

Old tailings and slimes were run by the American Zinc, Lead & Smelting Co., Birthday Mining Co., Childress Lead & Zinc Co., Commonwealth Mining Co., Moyer Milling Co., New Chicago Mines Corporation (Vantage & Premier), Oko Mine, and C. W. Theurer.

The estimated quantity of old tailings and slimes re-treated was 910,700 tons, from which were recovered 70 tons of galena concentrates and 12,416 tons of sphalerite concentrates (56.8 per cent zinc).

The Bingham mine lease was abandoned late in 1928 and the Jefferson mine, which was idle, was sold to the United States Zinc Smelting Corporation. The Leonora mill was remodeled to treat tailings, and the Hunt mill was used to treat crude ore mined at the Little mine near Blue Mound in Kansas.

WISCONSIN

By J. P. DUNLOP

Mine production of lead and zinc in Wisconsin in 1928, by districts

District	Lead concentrates		Zinc concentrates				Metal content ¹			
			Sphalerite		Silicate and carbonate		Lead		Zinc	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Benton-New Diggings.....	243	\$17,665	10,856	\$220,037	-----	-----	168	\$19,488	3,135	\$382,470
Cuba City and Platteville..	140	10,472	4,918	95,103	-----	-----	100	11,600	1,510	184,220
Dodgeville.....	319	23,599	2,682	63,438	-----	-----	222	25,752	865	105,530
Hazel Green and Linden..	200	15,385	20,171	384,096	-----	-----	147	17,052	5,400	658,800
Highland.....	-----	-----	124	3,022	488	\$7,767	-----	-----	194	23,668
Shullsburg.....	1,512	109,830	32,959	480,188	-----	-----	1,061	123,076	7,313	892,186
	2,414	176,951	71,710	1,245,884	488	7,767	1,698	196,968	18,417	2,246,874
Total, 1927.....	2,914	237,381	130,039	2,239,369	755	13,473	2,069	260,694	32,841	4,203,648

¹ In calculating the metal content of the ores from assays allowance has been made for roasting and smelting losses of both lead and zinc. In comparing the values of ore and metals it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead and zinc is calculated from the average price for all grades.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1925-1928

	1925	1926	1927	1928
Total ore.....short tons..	1,003,700	1,440,300	1,480,800	733,500
Total concentrates in ore:				
Lead.....per cent..	0.26	0.16	0.20	0.33
Zinc.....do.....	7.62	7.03	8.83	9.84
Metal content of ore:				
Lead.....do.....	0.19	0.13	0.14	0.23
Zinc.....do.....	2.53	2.38	2.79	3.26
Average lead content of galena concentrates.....do.....	72.8	67.2	72.4	71.7
Average zinc content of sphalerite concentrates.....do.....	32.8	33.8	31.6	33.1
Average zinc content of zinc carbonate concentrates.....do.....	34.1	32.3	32.7	34.0
Average value per ton:				
Galena concentrates.....	\$105.62	\$93.02	\$81.46	\$73.30
Sphalerite concentrates.....	\$22.66	\$21.89	\$17.22	\$17.37
Zinc carbonate concentrates.....	\$22.51	\$25.05	\$17.85	\$15.92

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette Counties and contain the most valuable part of the ore deposits of the upper Mississippi Valley region, a historical review of which is given in the Illinois section of this report in *Mineral Resources for 1914*. A detailed description of the Wisconsin lead and zinc districts and of the mines in each district to the year 1906 is given by Bain.⁶ The development of the mines subsequent to Bain's report and the output of Wisconsin mines have been set forth in *Mineral Resources* since 1906.

Roasting and electromagnetic separation have been utilized in the district for many years to produce a marketable zinc product. Comparatively few of the concentrating plants are equipped with roasters, but the larger mining interests own or control separating plants,⁷ and nearly all the raw concentrates were roasted.

The roasting and separating plants operated in Wisconsin in 1928 were those of the National Zinc Separating Co., at Cuba City, and the Mineral Point Zinc Co., at Mineral Point. The shipments made came from about 25 mines, many of which were small and were operated spasmodically.

The total value of the mine output of lead and zinc in Wisconsin in 1928 was \$2,443,842 compared with \$4,464,342 in 1927. The quantity of lead concentrates sold decreased from 2,914 tons in 1927 to 2,414 tons in 1928, and the quantity of sphalerite concentrates from 130,039 tons to 71,710 tons. The quantity of lead from galena concentrates was 371 tons less than in 1927, and the quantity of zinc from sphalerite and zinc carbonate concentrates decreased 14,424 tons.

About 65 per cent of the galena and 70 per cent of the sphalerite shipped were the output of the Vinegar Hill Zinc Co., although about 10 mills were operated by other companies. Development was not active, although considerable drilling was done during 1928.

The metal content of the raw sphalerite concentrates shipped in 1928 ranged from 25 to 50 per cent. Thirty-six per cent of the sphalerite ranged between 32 and 38 per cent zinc content, and 27 per cent of the total shipments averaged less than 30 per cent. The zinc content of the roasted sphalerite concentrates shipped was 57 to 58 per cent.

The crude ore yields a high recovery in concentrates, frequently 10 to 15 per cent, but the sphalerite concentrates, which now constitute nearly all the material shipped, are usually of considerably lower zinc content than those of the other Central States. There was a very large decrease in the output and shipments of zinc concentrates in 1928 compared with 1927. This was due to the complete idleness of mines and mills on fee simple lands of the Mineral Point Zinc Co., in so far as company operations were concerned. The Mineral Point Zinc Co. shipments in 1928 were of concentrates milled late in 1927 and of concentrates made by small lessees. Some concentrates were purchased for the Mineral Point Zinc Co.'s roasting and separating plant, but the bulk of the zinc concentrate was shipped to the separating and acid plant of the National Zinc

⁶ Bain, H. F., *Zinc and Lead Deposits of the Upper Mississippi Valley*: U. S. Geol. Survey Bull. 294, 1906, pp. 81-148.

⁷ Deutman, E. G., *The Roasting and Magnetic Separation of Wisconsin Zinc Ores*: Eng. and Min. Jour., June 28, 1919, pp. 1107-1111.

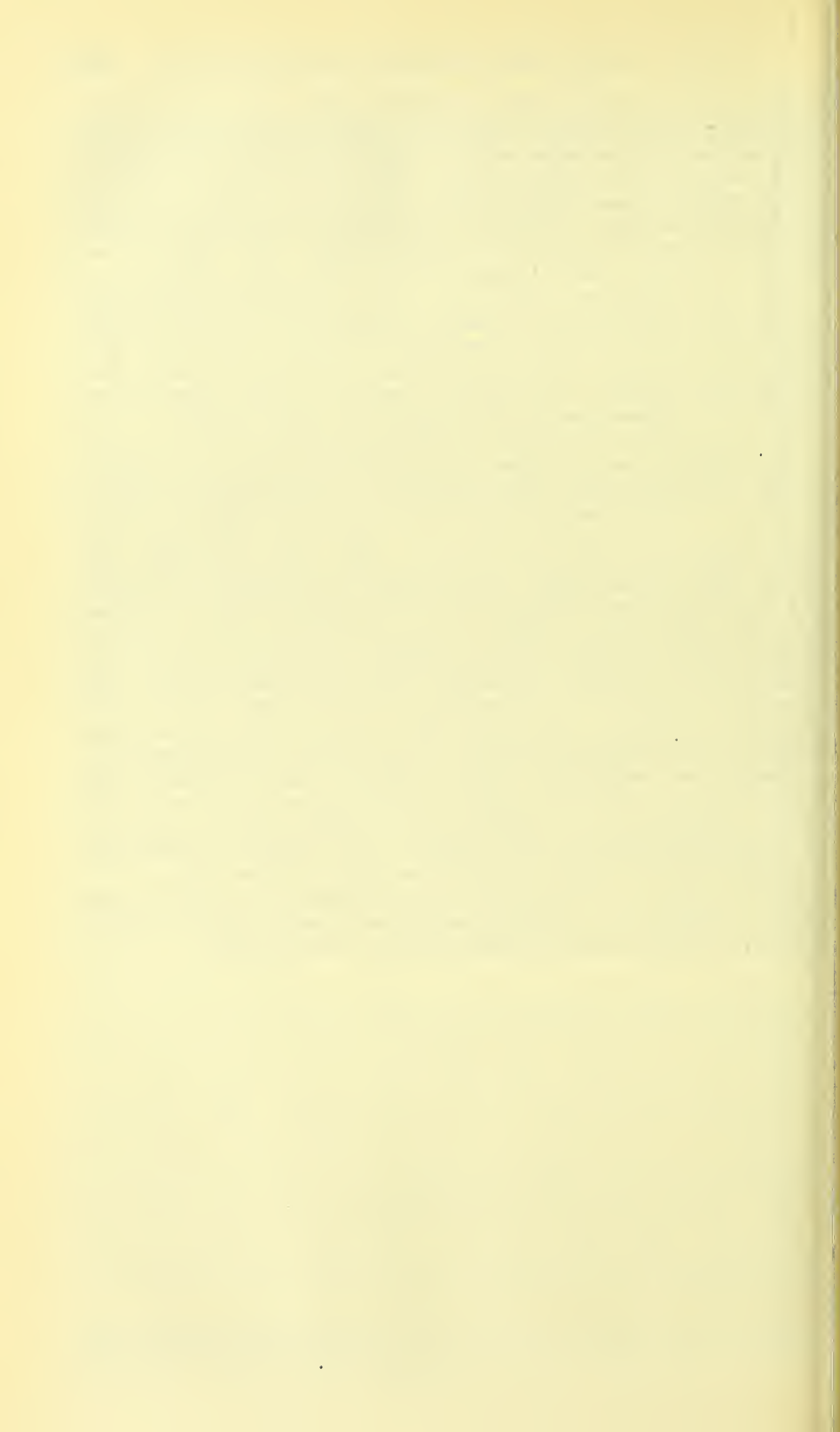
Separating Co. at Cuba City. Probably less than 1,000 tons of the sphalerite concentrates shipped in 1928 went directly to retort smelters and the remainder went to separating plants in Wisconsin.

The output of zinc carbonate ore, which is mined almost entirely in the Highland and Mineral Point districts, has been very small in the last five years. This ore is purchased by the Mineral Point Zinc Co. for the oxide plant at Mineral Point. The shipments of zinc carbonate ore were 755 tons in 1927 and 488 tons in 1928.

The total shipments in 1928 from mines in the upper Mississippi Valley region (Illinois and Wisconsin) amounted to 71,779 tons of sphalerite, 488 tons of zinc carbonate, and 2,425 tons of galena. The average zinc content of the raw sphalerite concentrates from Wisconsin sold in 1928 was 33.1 per cent, and the average value per ton was \$17.37, compared with 31.6 per cent and \$17.22 in 1927.

The only active tailing mill in 1928 was that of Chas. Lawyer at the Winskill dump. Mines in the Shullsburg district produced 63 per cent of the galena and 46 per cent of the sphalerite shipped in 1928. The Vinegar Hill Zinc Co. worked the Birkett mine at Hazel Green and the Mullen and James mines near Shullsburg. The other large shippers of concentrates in 1928 were the Badger Zinc Co. at Linden (Rule mine), the Blockhouse at Platteville, the Ellis and the Lucky Five at Dodgeville, and the Ida Blende at Benton. Other shippers of concentrates were the Bull Moose Mining Co. and Mineral Point Zinc Co. at New Diggings and Fox & Lee and M. Frazier at Cuba City. The Middie and Bull Moose mines were operated six months and abandoned in July, 1928. Some of the properties formerly worked by the Mineral Point Zinc Co. are being drilled by the Vinegar Hill Zinc Co. The Paris Hill Mining Co. continued its development of the McCabe land at Benton. The Curwin mine at Benton was idle, but operations were resumed in 1929. Developments at the Rule mine at Linden proved a large area of ore-bearing ground at the 120-foot level, and the concentrates recovered will be of better grade than usual in Wisconsin.

For descriptions of old mines, concentrating plants, and roasting plants in which no essential changes were made during 1928 the reader is referred to Mineral Resources for recent years.



MANGANESE AND MANGANIFEROUS ORES

By LEWIS A. SMITH ¹

STATISTICAL SUMMARY

Salient figures of the manganese industry in the United States, 1927-28

	1927		1928	
	Long tons	Value	Long tons	Value
Domestic shipments:				
Total ore containing 35 per cent or more Mn.....	44,741	\$1,151,918	46,860	\$1,214,853
Metallurgical ore.....	27,730	446,781	31,430	593,561
Chemical ore.....	17,011	705,137	15,430	621,292
Number of producing mines:				
Total.....	39		38	
Metallurgical ore.....	36		35	
Chemical ore.....	3		3	
Imports:				
Manganese ore.....	622,067	8,487,016	427,708	5,395,949
Ferromanganese (manganese content).....	36,400	3,553,465	48,844	4,899,374
In bonded warehouse Dec. 31, 1928:				
Manganese ore (manganese content).....	183,477	5,043,193	114,497	4,049,731
Ferromanganese (manganese content).....	6,436	811,171	5,040	612,150

INTRODUCTION

Domestic mines in 1928 shipped 46,860 long tons of high-grade manganese ore, as compared with 44,741 tons in 1927 and 46,258 tons in 1926. Shipments of ferruginous manganese and manganiferous iron ores amounted to 1,175,982 long tons in 1928, compared with 1,458,418 tons in 1927 and 1,199,724 tons in 1926. The 1928 decrease is accounted for largely by the fact that the shipments of Wisconsin ores in 1928 averaged less than 5 per cent manganese and were classed as iron ore, whereas the 1927 shipments of manganiferous iron ores include 284,470 tons of Wisconsin ore containing over 5 per cent manganese. Imports of manganese ores, including chemical ore, amounted to 427,708 long tons, a decrease of 194,359 tons as compared with 1927. The ores in stock in bonded warehouses on December 31, 1928, contained 114,497 long tons of metallic manganese, 68,980 tons less than the metallic content of stocks on December 31, 1927. Notwithstanding the sharp decrease in imports there was probably no decrease in the consumption of manganese, as in recent years the steel companies have drawn heavily on

¹ The statistics in this report were prepared (unless otherwise stated) by H. M. Meyer and the data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the Bureau of Mines.

their warehouse stocks. The effect of this has been to pass the burden of carrying stocks to foreign producers, and in 1928 foreign production exceeded exports in some of the main producing countries. An increase in the consumption of manganese ore in steel manufacture in the United States is indicated by the record production of steel in 1928, amounting to 51,544,180 long tons, compared with 44,935,185 tons in 1927 and 48,293,763 tons in 1926.

During 1928 a considerable tonnage of ferruginous manganese ore and manganiferous iron ore was imported, mainly from Brazil, Africa, and Australia. This ore is desirable because its high metallic content and low silica and alumina permit mixture with high-silica, low-iron, high-manganese ores for the manufacture of ferromanganese. The increased metallurgical efficiency developed in the manufacture of ferromanganese has made the mixing of different ores possible, and a recovery of about 85 per cent of the manganese content of the ores used has been attained. In 1927 and 1928 the United States imported ferromanganese chiefly from Canada, the United Kingdom, and Norway, and a little was drawn from France, Italy, Sweden, and Germany. There has, however, been a growing tendency on the part of the American steel firms to manufacture their own ferromanganese from domestic and foreign ores. There was an increase in imports of ferromanganese during 1928 following the decrease in 1927 as compared with 1926.

In the United States the outstanding features of the year were: (a) Continued research on new methods for the beneficiation of low-grade ores and improvement of methods in use prior to 1928; (b) favorable development of the Little Floridas deposits near Deming, N. Mex.; (c) accomplishment by the Domestic Manganese & Development Co.'s sintering plant at Butte, Mont., of reducing the silica content of the sintered product to less than 8 per cent; (d) the development of new deposits near Las Vegas, Nev., and exploration in the Chamberlain district, South Dakota, the former having a fairly large tonnage of good grade ore and the latter indicating a large tonnage of material containing nodules averaging about 16 per cent manganese and 8 per cent iron; (e) the utilization of hydraulic mining methods and the construction of a large concentrating plant near Cartersville, Ga.; (f) the continued importation of manganiferous iron ores and of ferruginous manganese ores; and (g) a substantial increase in both imports and exports of ferromanganese.

The first annual meeting of the American Manganese Producers Association took place in Washington, D. C., in September, 1928, and a number of questions of importance were discussed, including progress made, tariff problems, beneficiation processes, etc. Later this organization instituted a campaign for the purpose of obtaining an additional one-half cent import duty per pound on high-grade ore and a downward extension of the dutiable limit to include 10 per cent manganese. This proposition has been opposed by representatives of the steel companies. The different schemes proposed to help

the manganese producer included the suggestion that the Government undertake to build up a reserve stock pile of domestic manganese ores to be used in case of military necessity.

From an international standpoint the development of the Postmasburg manganese deposit in Cape Colony, South Africa, and the withdrawal of the Harriman interests from the Chiaturi concession in Russia were the principal events during 1928. Other interesting features include (a) the continued development and high rate of production in the Indian deposits; (b) the discovery of promising deposits in Persia and Russia; (c) the favorable development of deposits in Java, Netherland East Indies; (d) the development of new deposits and the entrance of British and French capital into the Bahia, Matto Grosso, and Minas Geraes fields in Brazil; (e) the increased importation of manganese ores by France; (f) the reentrance of Russian ores into the world market at reduced prices in August, following a period of inactivity that resulted from the withdrawal of the Harriman interests; (g) the betterment of rail facilities and the building of a new harbor at Vizagapatam, India; (h) the near completion of the harbor at Takoradi in Gold Coast; and (i) the entrance of a German firm into the Makri field in Asiatic Turkey.

During the past few years high-grade metallurgical ore has been divided into two classes—ore in which the tenor of manganese is above 50 per cent, usually washed ore, and ore with a tenor of 45 to 50 per cent. The average prices of metallurgical ore per long ton unit c. i. f. Atlantic seaboard for 1928 were: Washed Caucasian, 38 to 40 cents; crude Caucasian, 33 cents; Chilean, 50 per cent ore, 38 cents; Indian, 47 per cent ore, 36 cents; and Brazilian high-grade, 36 cents. For chemical ores c. i. f. Atlantic seaboard: Domestic, 70 to 72 per cent, manganese dioxide content, \$40 to \$50 per ton; Montana chemical ore, 70 to 75 per cent, quoted at \$70 to \$80; Brazilian and Cuban chemical ore, 82 to 87 per cent plus manganese dioxide content, \$70 to \$80; and Caucasian, minimum 85 per cent manganese dioxide, \$70 per ton.

UNITED STATES

PRODUCTION

In 1928 the mines of the United States shipped 46,860 tons of metallurgical and chemical manganese ore, valued at \$1,214,853, compared with 44,741 tons, valued at \$1,151,918, in 1927, an increase of nearly 5 per cent in quantity and more than 5 per cent in value. Shipments of metallurgical ore in 1928 amounted to 31,430 tons, valued at \$593,561, an increase of 13 per cent over 1927. Shipments of chemical ore amounted to 15,430 tons, valued at \$621,292, a decrease of 9 per cent. Montana produced 38 per cent of the metallurgical ore in 1928. Of the domestic output of chemical ore in 1928, Montana produced 95 per cent and Virginia 5 per cent.

MANGANESE ORE

The total output of high-grade ores during the last three years has been steadily around 45,000 tons, but the share in the total represented by metallurgical ores has increased from about 26,530 tons in 1926 to 31,430 tons in 1928, and chemical ores have decreased gradually from 22,151 tons in 1925 to 15,430 tons in 1928.

Manganese alloys and ore produced in the United States and imported from principal foreign sources, 1919-1928, in long tons

Year	Steel (production) ¹	Ferromanganese		Spiegeleisen		Manganese ore				
		Shipments	Imports	Shipments	Imports	Shipments ²	Total imports	Imports from—		
								Russia	India	Brazil
1919----	34, 671, 232	198, 255	33, 022	90, 855	27	54, 957	333, 344	6, 916	9, 200	246, 592
1920----	42, 132, 934	276, 594	59, 254	103, 672	5, 234	94, 420	³ 599, 764	18, 762	71, 238	421, 523
1921----	19, 783, 797	111, 374	9, 077	69, 230	307	13, 531	³ 392, 606	-----	113, 730	262, 468
1922----	35, 602, 926	161, 612	⁴ 100, 725	70, 253	8, 151	13, 404	⁴ 425, 000	⁵ 24, 250	⁶ 234, 598	⁷ 40, 595
1923----	44, 943, 696	226, 365	⁴ 113, 833	134, 086	4, 668	31, 500	⁴ 419, 000	⁶ 1, 642	⁷ 25, 568	⁷ 88, 036
1924----	37, 931, 939	232, 821	⁴ 56, 588	76, 179	7, 433	56, 515	⁴ 505, 000	⁷ 11, 670	⁷ 54, 566	⁷ 54, 938
1925----	45, 393, 524	254, 005	⁴ 78, 713	95, 890	1, 090	98, 324	⁴ 615, 000	⁷ 114, 537	⁷ 23, 504	⁷ 109, 650
1926----	48, 293, 763	330, 070	⁴ 59, 710	82, 982	8, 783	46, 258	⁴ 738, 000	⁷ 122, 345	⁷ 30, 596	⁷ 130, 693
1927----	44, 935, 185	291, 056	⁴ 45, 500	80, 892	7, 529	44, 741	622, 067	253, 544	93, 017	174, 026
1928----	51, 544, 180	310, 122	⁴ 61, 055	116, 911	5, 260	46, 860	427, 708	159, 842	83, 600	142, 300

¹ According to American Iron and Steel Institute.

² Exclusive of small quantities of ore shipped for use in fluxing.

³ Exclusive of 7,173 tons in 1920 and 8,748 tons in 1921 reported by Bureau of Foreign and Domestic Commerce as manganese ore. The value of this "ore" ranged from \$46 to \$292 a ton; consequently the Bureau of Mines believes that the figures represent imports of ferromanganese, spiegeleisen, manganese chemicals, and perhaps some chemical ore.

⁴ From Sept. 22, 1922, to Dec. 31, 1926, the Bureau of Foreign and Domestic Commerce reported only the manganese content of the manganese ore and ferromanganese imported; since 1927 the bureau has reported the gross weight of the ore but only the manganese content of the ferromanganese. This figure is a Bureau of Mines estimate of the gross weight of ore or alloy imported. For the figures reported by the Bureau of Foreign and Domestic Commerce, see the tables on pp. 220 and 227.

⁵ Jan. 1 to Sept. 21, 1922. Figures represent gross weight of manganese ore imported.

⁶ Sept. 22 to Dec. 31, 1922. Figures represent manganese content of ore imported.

⁷ Figures represent manganese content of ore imported.

Manganese and manganiferous ore shipped from mines in the United States, 1919-1928, in long tons

Year	Manganese and manganiferous ores, exclusive of fluxing ore			Fluxing ore containing manganese		
	Ore containing 35 per cent of manganese or more	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese	Ore containing 35 per cent of manganese or more	Ore containing 10 to 35 per cent of manganese	Ore containing 5 to 10 per cent of manganese ¹
1919-----	54, 957	211, 632	112, 303	365	98, 202	11, 596
1920-----	94, 420	357, 279	279, 687	-----	123, 970	6, 728
1921-----	13, 531	8, 439	62, 670	-----	22, 962	3, 028
1922-----	13, 404	344, 674	251, 614	2, 278	27, 705	1, 666
1923-----	31, 500	319, 666	1, 072, 457	769	40, 770	1, 004
1924-----	56, 515	286, 470	587, 026	1, 833	24, 972	-----
1925-----	98, 324	267, 252	1, 153, 268	-----	25, 384	2, 150
1926-----	46, 258	364, 312	835, 412	-----	17, 707	-----
1927-----	44, 741	148, 291	1, 310, 127	-----	1, 029	2, 161
1928-----	46, 860	90, 581	1, 085, 401	-----	48	1, 602

¹ Includes ore containing less than 5 per cent of manganese, as follows: 1919, 844 tons; 1920, 1,250, tons; 1921, 998 tons; 1922, 117 tons.

Manganese and manganiferous ore (exclusive of fluxing ore) shipped from mines in the United States, 1925-1928, by States

	Ore containing 35 per cent or more of manganese			Ore containing 10 to 35 per cent of manganese			Ore containing 5 to 10 per cent of manganese		
	Ship-pers	Long tons	Value	Ship-pers	Long tons	Value	Ship-pers	Long tons	Value
1925									
Metallurgical.....	38	76, 173	\$954, 799	53	267, 252	\$915, 316	11	1, 153, 268	\$2, 799, 403
Chemical.....	4	22, 151	902, 970						
	42	98, 324	1, 857, 769	53	267, 252	915, 316	11	1, 153, 268	2, 799, 403
1926									
Metallurgical.....	30	26, 530	379, 893	54	364, 312	1, 179, 429	8	835, 412	1, 934, 381
Chemical.....	4	19, 728	848, 770						
	34	46, 258	1, 228, 663	54	364, 312	1, 179, 429	8	835, 412	1, 934, 381
1927									
Metallurgical:									
Alabama.....	2	(1)	(1)	2	(1)	(1)			
Arizona.....	3	3, 905	41, 880	1	179	754			
Arkansas.....	8	2, 605	64, 202	6	7, 444	48, 678			
Colorado.....	1	(1)	(1)	5	26, 828	126, 938			
Georgia.....	2	489	(1)	16	20, 015	135, 606	1	195	(1)
Idaho.....	1	3, 181	50, 900						
Massachusetts.....				1	(1)	(1)			
Michigan.....				1	14, 763	(1)	1	59, 976	(1)
Minnesota.....				1	6, 276	22, 272	4	934, 599	2, 169, 779
Montana.....	4	10, 124	158, 900	1	10, 332	(1)			
Nevada.....	3	1, 357	16, 976	2	3, 310	(1)			
New Mexico.....	2	3, 190	37, 237	1	56, 624	(1)	1	30, 710	(1)
Tennessee.....	3	498	8, 182	3	487	3, 442			
Utah.....	1	27	(1)	4	239	(1)			
Virginia.....	5	2, 583	48, 860	3	1, 029	7, 500	1	177	(1)
Wisconsin.....							1	284, 470	818, 604
Undistributed.....		771	19, 644		765	328, 731			282, 077
Total metallurgical.....	36	27, 730	446, 781	47	148, 291	673, 921	9	1, 310, 127	3, 270, 460
Chemical:									
Montana.....	2	16, 382	705, 137	{					
Virginia.....	1	629							
Total chemical.....	3	17, 011	705, 137						
	39	44, 741	1, 151, 918	47	148, 291	673, 921	9	1, 310, 127	3, 270, 460
1928									
Metallurgical:									
Alabama.....	2	(1)	(1)						
Arizona.....	5	3, 507	35, 500	1	214	(1)			
Arkansas.....	6	3, 623	81, 862	4	7, 136	43, 880			
Colorado.....				4	18, 599	99, 823			
Georgia.....	1	4, 727	(1)	8	4, 687	41, 322			
Idaho.....	2	(1)	(1)						
Michigan.....				2	7, 943	(1)	1	41, 261	(1)
Minnesota.....				1	3, 487	(1)	5	1, 025, 014	2, 471, 582
Montana.....	3	12, 044	(1)	1	11, 156	(1)			
New Mexico.....	3	2, 627	(1)	2	36, 250	(1)	1	19, 081	(1)
North Carolina.....	1	10	(1)						
Tennessee.....	2	55	(1)	5	718	6, 778	1	45	(1)
Utah.....				1	286	(1)			
Virginia.....	10	3, 071	50, 106	2	105	(1)			
Undistributed.....		1, 766	426, 093			215, 486			173, 583
Total metallurgical.....	35	31, 430	593, 561	31	90, 581	407, 289	8	1, 085, 401	2, 645, 165
Chemical:									
Montana.....	2	14, 689	621, 292	{					
Virginia.....	1	741							
Total chemical.....	3	15, 430	621, 292						
	38	46, 860	1, 214, 853	31	90, 581	407, 289	8	1, 085, 401	2, 645, 165

*Included under "Undistributed." *Mills through which all ore was shipped; producers not counted.

The following States produced, in the order named, substantial quantities of metallurgical ore in 1928: Montana, Georgia, Arkansas, Arizona, Virginia, New Mexico, and Idaho. The output of Montana increased about 2,000 tons in 1928, Georgia increased from 489 tons in 1927 to 4,727 tons in 1928, and Arkansas increased about 1,000 tons. The production in Arizona decreased about 400 tons in 1928, whereas that in Virginia increased about 500 tons. New Mexico increased about 20 per cent in 1928. The Bureau of Mines is not at liberty to publish the individual production in Idaho and Alabama. Nevada produced more than 1,300 tons in 1927, but reported no production for 1928. Chemical ore is produced in only two States, Montana and Virginia, the former contributing 95 per cent and the latter 5 per cent of the 1928 output. The production in Montana decreased 10 per cent in 1928, whereas that in Virginia increased 18 per cent.

In the spring of 1928 the Domestic Manganese & Development Co. began commercial operations at its Butte (Mont.) plant. Rhodochrosite running 36 to 38 per cent manganese was successfully calcined into a sintered product containing 56 to 58 per cent manganese. During the first operations the product was high in silica, but subsequent experimentation resulted in reduction of the silica content to less than 8 per cent. During 1928 more than 18,000 tons of rhodochrosite was handled and 11,000 tons of nodulized product obtained. The "pink ore" is being mined in the Emma mine at Butte.

The Bradley process, the development of which has cost nearly \$400,000, has been perfected technologically. This new process was devised mainly for the beneficiation of low-grade manganiferous ores of the Lake Superior region, now used in the manufacture of pig iron, and the sponsors believe that this process will find a large field of application. Should the process prove economic, there is a probable reserve of several million tons of low-grade ore to which it may be applied in the Lake region and in other sections of the country. The Bradley-Fitch Co. estimates the cost of producing 1 ton of concentrates running 63½ per cent manganese from ores ranging 13½ per cent manganese to be about \$32.61. On the basis of the average domestic price in 1928 it is claimed that this product would have a market value of \$39.62 per ton. Construction of a plant that will have an ultimate annual capacity of 100,000 tons of sintered product has been proposed.

The application of hydraulic mining methods in the Cartersville district, Georgia, eventually should reduce the mining cost there and at the same time enable the operators to handle a larger tonnage. It is said that approximately \$750,000 is to be expended in the near future on retaining dams and milling equipment.

FERRUGINOUS MANGANESE ORE

Shipments of domestic ore carrying 10 to 35 per cent manganese amounted to 90,581 long tons, valued at \$407,289, as compared with 148,291 tons, valued at \$673,921, in 1927, a decrease of 39 per cent in quantity and 40 per cent in value. The decrease in the last two or three years has been due to a slump in grade of the ores close to the lower limit of the class and to decreased output from Michigan and Minnesota mines.

A considerable tonnage of ferruginous manganese ore and of manganiferous iron ore was imported into the United States during the year, practically all from Brazil, Africa, Spain, and Sinai Peninsula. Foreign ore used in the United States during 1928 amounted to around 117,000 long tons and contained from 5 to 29 per cent manganese.

MANGANIFEROUS IRON ORE

Shipments of manganiferous iron ore in 1928 amounted to 1,085,401 long tons, valued at \$2,645,165, as compared with 1,310,127 tons, valued at \$3,270,460, in 1927. The decrease in 1928 was attributable almost wholly to the arbitrary method of classification used by the Bureau of Mines, whereby ores containing 5 per cent or more manganese are classified as manganiferous iron ores whereas ores under 5 per cent are classified as iron ores. The 1927 production of manganiferous iron ore included 284,470 tons of ore shipped from Wisconsin mines containing just over 5 per cent manganese. The 1928 production from these same properties averaged just under 5 per cent and has been classed as iron ore by the Bureau of Mines. Ores of this nature are marketed at a common valuation for their combined content of iron and manganese; as there is no monetary advantage to the shipper, more selective mining to improve the manganese content is not practical.

There is a large tonnage of material in the Lake Superior district and possibly also in the Chamberlain (S. Dak.) district, containing high percentages of silica and phosphorus or other deleterious impurities, which may become available for use should some process be developed for the beneficiation of material of this class.

CHEMICAL ORE

The shipments of chemical ore from domestic mines in 1928 amounted to 15,430 long tons, valued at \$621,292, compared with 17,011 tons, valued at \$705,137, in 1927, marking a decrease of 9 per cent in quantity and 12 per cent in value. The 1928 average price of imported chemical ore, powdered, coarse, or fine, 80 to 82 per cent manganese dioxide, was \$70 to \$80 a ton c. i. f. Atlantic seaboard. The average price of domestic ore, 70 to 72 per cent dioxide, was \$40 to \$50 a ton.

The major part of the chemical ores shipped from mines in the United States has come from the Philipsburg district, Montana. The increased use of flash-light batteries and the increased export trade in radio batteries have offset in part the decrease in batteries used in the domestic radio equipment. In the last few years the use of "socket power" in place of batteries in radios has increased enormously in the United States. A product that may eventually find its way into the battery trade is relatively pure manganese dioxide that is now produced as a by-product in the Tainton electrolytic process for reduction of zinc ore. Thus far this product has been returned for use in the process itself or stored for future sale. It is said to meet all requirements of battery manufacturers. It is now being produced at the plant of the Sullivan Mining Co. at Kellogg, Idaho; it will be produced at a similar plant of the Evans-Wallowa Zinc Co. at St.

Louis which will be in operation by the latter part of 1929. Much of the chemical ore now used in the United States is imported from Russia, Cuba, Gold Coast, Porto Rico, and Java.

Chemical manganese ore shipped from mines in the United States, 1919-1928, by States

Year	California		Idaho		Montana		Virginia		Total	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
1919.....	179	(¹)	-----	-----	19,896	(¹)	-----	-----	20,075	\$797,163
1920.....	-----	-----	-----	-----	14,809	(¹)	18	(¹)	14,827	539,543
1921.....	-----	-----	-----	-----	11,129	\$444,981	102	\$3,000	11,231	447,981
1922.....	-----	-----	-----	-----	9,706	(¹)	800	(¹)	10,506	404,965
1923.....	-----	-----	-----	-----	19,540	646,225	900	40,000	20,440	686,225
1924.....	-----	-----	-----	-----	23,512	816,463	1,125	50,000	24,637	866,463
1925.....	-----	-----	-----	-----	20,529	825,970	1,622	77,000	22,151	902,970
1926.....	-----	-----	30	(¹)	17,904	(¹)	1,794	(¹)	19,728	848,770
1927.....	-----	-----	-----	-----	16,382	(¹)	629	(¹)	17,011	705,137
1928.....	-----	-----	-----	-----	14,689	(¹)	741	(¹)	15,430	621,292

¹ Bureau of Mines not at liberty to publish figures.

REVIEW BY STATES

ALABAMA

A small quantity of manganese ore was shipped during 1928, but the Bureau of Mines is not at liberty to publish the figures.

ARIZONA

Arizona shipped 3,507 long tons of ore averaging more than 40 per cent manganese in 1928, a decrease of 10 per cent from the 3,905 tons shipped in 1927. The largest producer was the Higgins mine in the Warren district, where psilomelane, pyrolusite, manganite, and some alabandite occur in lenticular ore bodies in the Escabrosa and Martin limestone (Carboniferous). The deposits are said to have been formed by the weathering of alabandite and possibly rhodochrosite. The reserves in the Warren district have been calculated at 50,000 tons of 35 per cent ore, most of which is situated in the Higgins mine, in exposures near the Sunrise shaft, and on the surface of the Czar and Holbrook properties. Mining costs in the Warren district slightly exceed costs in the Little Floridas and Silver City districts of New Mexico, as the material is somewhat harder to break. Freight rates from Arizona to eastern points are also higher.

Manganese ore running 35 per cent or more manganese was shipped from the Black Warrior mines at Congress, the mine of the Bagdad Copper Co. at Hillside, the Ben McCloskey mine near Winslow, and the mine of the United States Manganese Co. at Aguila.

The Black Warrior mine was active during the year. A considerable tonnage of 35 to 40 per cent ore is said to have been developed, the main mineral being pyrolusite. The United States Manganese Co. has ore containing about 40 per cent manganese. Deposits on the east slope of the Virgin Mountains and the west slope of the Hualpai Mountains, both in Mohave County, are said to have favorable exposures.

ARKANSAS

In 1928 Arkansas shipped 3,623 long tons of ore containing 35 per cent or more of manganese as compared with 2,605 tons in 1927, an increase of 39 per cent. The shipments of ferruginous manganese ore in 1928 amounted to 7,136 tons compared with 7,444 tons in 1927. The operators in 1928 were the Arkansas Manganese Ore Co., Walter Denison, Beatty & Shell, M. R. W. Mining Co., A. B. Reither, and J. I. Rowe, all located in the Batesville-Cushman field, with the exception of Rowe, who operated at Caddo Gap. Most of the high-grade ore shipped contained about 46 per cent manganese, some running higher. The iron content ranged from 7 to 15 per cent and silica from 4 to 16 per cent. All of the high-grade ore is said to be produced by concentration. A considerable quantity of ferruginous manganese ore running from 20 to 25 per cent manganese, 18 to 20 per cent iron, 14 per cent silica, and 12 per cent alumina was produced in 1927 and 1928.

CALIFORNIA

Development work was done on the Ferro Manganese mine, San Diego County. The Manganese Mines Co., Stanislaus County, expects to produce 500 tons per month during 1929 at the Buckeye mine, and is planning to develop two other properties. Some of the ore is said to run 45 per cent, and there is a considerable amount of 35 per cent ore developed which can be concentrated up to 45 and 50 per cent.

The successful application of sintering methods at Butte suggests the possibility of beneficiating a similar carbonate ore in the old Ladd mine.

COLORADO

No production of high-grade ores was reported during 1928, although a small quantity was reported during 1927. Shipments of ferruginous manganese ore (excluding fluxing ores) amounted to 18,599 long tons during 1928, whereas 26,828 tons was shipped in 1927. The ore contains 19 to 25 per cent manganese. The principal producing area is in the Leadville district, shipments averaging between 50 and 100 tons per day, and the ore is said to average around 19 to 21 per cent manganese, 20 per cent iron, 7.5 per cent silica, 0.043 per cent phosphorus, and 17 per cent moisture. Production declined in this district during 1928.

The Manganese Mining Co. at Paymaster drove crosscuts on two veins at a depth of 200 and 300 feet, respectively.

GEORGIA

Shipments of high-grade ore containing 35 per cent or more manganese amounted to 4,727 long tons in 1928 compared with 489 tons in 1927. Shipments of ferruginous manganese ore amounted to 4,687 tons in 1928 compared with 20,015 tons in 1927. No shipments of manganiferous iron ore were made during 1928 compared with 195 tons shipped in 1927. Practically all of the ore shipped came from

the Cartersville district, where important developments are progressing. The Georgia Manganese & Iron Co. is operating an experimental washing plant which, it is claimed, is making 50 tons of concentrates a day. It is said that the product averages 30 to 45 per cent manganese. The ore is mined by hydraulic methods. The company employs some 250 men, of whom 75 are operating the pilot plant and 175 are erecting a new plant that will cost \$750,000 and is rated at an annual capacity of 200,000 tons of ore. The company owns about 15,000 acres, 30 of which have been drilled and are said to contain enough ore to supply the new plant for 10 years. One deposit exposed in a prospect pit showed psilomelane that might be rich enough for direct shipment.

A dam that will impound 375,000,000 gallons of water is under construction. This dam is about 2 miles from the mine and when completed will contain 168,000 cubic feet of fill and be 55 feet high. In a gulch near by is a second dam 40 feet high, flooding 75 acres and holding 320,000,000 gallons. In mining operations the ore is washed to a central sump in the bottom of the pit, where coarse ore and rock are removed on a grizzly. The undersize is pumped to the washing plant and put through a 28-foot log washer followed by four 2-compartment jigs. The fines from the jigs go to four Diester tables, which produce a concentrate and a middling product. The latter is ground in a rod mill and returned to the tables.

P. W. Cornwell, of White, Ga., is the superintendent and Capt. John Cunningham, also of White, the resident engineer representing the New York people who are financing the operations.

Bob Casey, L. F. Richards, and James R. Whitaker, of White, were among the leading operators in the Cartersville district in 1928.

IDAHO

A considerable quantity of 50 per cent manganese ore was produced in Idaho during 1928, but the Bureau of Mines is not at liberty to publish the actual figures. During 1927 shipments of high-grade ore containing 45 per cent or more manganese amounted to 3,181 long tons. During 1928 the Western Manganese Mining Co. (formerly the Idaho Manganese Mining Co., of Cleveland, Idaho) and R. E. Wickham, of Lava Hot Springs, Idaho, were the only producers.

MICHIGAN

The shipments of ferruginous manganese ore amounted to 7,943 long tons averaging 16.8 per cent manganese in 1928 compared with 14,763 tons averaging 17 per cent manganese in 1927. The 1928 shipments of manganiferous iron ore amounted to 41,261 tons compared with 59,976 tons in 1927. In 1928, 333,091 long tons of iron ore averaging 3.58 per cent manganese natural, or 3.85 per cent manganese dry, were shipped compared with 402,916 tons averaging 3.51 per cent manganese natural, or 3.76 per cent manganese dry, during 1927.

Barrett² lists the reasonably assured reserves of manganiferous iron ore from the Marquette, Gogebic, and Menominee iron ranges of

²Joseph, T. L., Barrett, E. P., and Wood, C. E., Production of Ferromanganese from Manganiferous Iron Ores: Proc. Am. Manganese Producers Association, September 10-11, 1928, p. 56.

Michigan and Wisconsin at 7,913,075 tons averaging 3.66 per cent manganese, 1,580,912 tons averaging 6.37 per cent manganese, and 1,670,941 tons averaging 12.5 per cent manganese, a total reserve of about 11,000,000 tons as compared with about 44,000,000 tons on the Cuyuna range in Minnesota. These ores are now being used in the manufacture of manganese pig iron or are mixed with high-grade manganese ore to provide iron in the manufacture of ferromanganese and spiegeleisen.

MINNESOTA

During 1928 shipments of ferruginous manganese ore amounted to 3,487 long tons compared with 6,276 tons in 1927, a decrease of 44 per cent. Shipments of manganiferous iron ore totaled 1,025,014 tons in 1928 compared with 934,599 tons in 1927, an increase of 10 per cent.

The manganiferous ore that occurs on the north ridge of the Cuyuna range is commonly high in phosphorus and low in silica or low in phosphorus and high in silica, the former having a lower manganese content and a lighter color than the latter. There is no appreciable amount of high-grade manganese ore on the range, but the demand for low-grade material with a combined iron and manganese content of 50 per cent makes possible the shipment of Cuyuna ores. According to Carl Zapffe,³ there is forty to fifty million tons of manganiferous iron ore in the Lake Superior region and elsewhere that will fulfill these requirements. In addition, the Cuyuna range and the area between the Cuyuna and Mesabi ranges contain millions of tons of lean and now useless material running 10 to 15 per cent manganese but with insufficient iron to bring the total iron-manganese content up to 50 per cent. Undesirable impurities, such as phosphorus and silica, are present in considerable quantities. Since 1922 Wilson Bradley, of Deerwood, Minn., and associates have experimented extensively in the development of an ammonium sulphate leaching process for recovering the manganese in this material. The final product is said to run from 63 to 70 per cent manganese. H. Brassert & Co., of Chicago, was associated with the Bradley interests and handled the engineering and economic features of the process. An experimental pilot mill has been operated for several years, and it is claimed that the process will prove commercially successful. The erection of a large mill for the application of this process has been proposed.

Experimental work was continued on pyrometallurgical recovery of manganese from Cuyuna ores⁴ by the United States Bureau of Mines at its Minnesota station.

The operators in Minnesota in 1928 were the Evergreen Mining Co. and the Amherst Mining Co., at Crosby; the Manganiferous Iron Co. and the Cuyuna Ore Co., at Ironton; and the Sagamore Ore Mining Co., at Riverton, all in Crow Wing County.

³ Zapffe, Carl, Reserves of Lake Superior Manganiferous Iron Ores: *Am. Inst. Min. and Met. Eng. Trans.*, vol. 75, 1927, p. 365.

⁴ Joseph, T. L., and Kinney, S. P., Minnesota Manganiferous Iron Ore in Relation to the Iron and Steel Industry: *Univ. of Minnesota Sch. Mines Exp. Sta.*, Bull. 12, Feb. 10, 1927, pp. 28-64; *Am. Inst. Min. and Met. Eng. Trans.*, vol. 75, 1927, pp. 292-338.

MONTANA

The shipments of metallurgical ore from Montana during 1928 amounted to 12,044 long tons compared with 10,124 tons in 1927. The shipments of chemical ore, containing 70 to 72 per cent manganese dioxide, amounted to 14,689 long tons in 1928 compared with 16,382 tons in 1927. Shipments of ferruginous manganese tailings amounted to 11,156 tons compared with 10,332 tons in 1927. The metallurgical ore came from Butte and Philipsburg.

The Domestic Manganese & Development Co., Butte, Mont., nodulized 18,595 long tons of rhodochrosite containing 37 per cent manganese and produced 11,118 tons of sintered product averaging over 56 per cent manganese but relatively high in silica. In 1927 this plant, then operated by the Anaconda Copper Mining Co., sintered 6,400 tons of rhodochrosite and produced 4,000 tons of concentrates. Whereas the product obtained during 1927 and 1928 was relatively high in silica, recent shipment records show that the silica content has been reduced to under 8 per cent or within the limits required for metallurgical ore.

The principal producers in the Philipsburg district in 1928 were the Moorlight Mining Co., the Silver Prince Mining Co., A. D. Stoddard & Co., and the Trout Mining Co. The Trout Mining Co. and the Moorlight Mining Co. operate magnetic concentrating plants. The Trout plant was described in the chapter of this series for 1927. The plant of the Moorlight Mining Co. has recently been described as follows:⁵

At the company's mill the ore, which runs about 6 to 10 per cent manganite, is trucked to the mill and then crushed to 1 to 1½ inches by a Blake crusher, the crushed ore being dried through a rotary drier which is fired by wood and coal—mostly wood. It is then run over coarse rolls. From here it goes over a ¼-inch mesh screen, through the fine rolls, and it is sized over 8, 14, and 18 inch mesh screens, respectively. These three sizes are then washed over the separators and the resultant product shipped for battery purposes. There are two separators with magnets, wound at 30,000, 60,000, and 100,000 ampere-turns, respectively, for taking off the manganese ore, and at the head of the machines additional poles are located for taking off the iron. The current used is 125 volts d. c., which is transformed from 2,200 volts a. c.

The output of the company totals about 18 tons a day, the concentrates running 48 per cent manganese and around 10 per cent silica and over 70 per cent dioxide. It is hauled to the railroad, about 2 miles away.

The Silver Prince Mining Co., at Philipsburg, did considerable development work during 1928 and now has a 2-compartment shaft down to a depth of 500 feet. Other work was done, including a raise from the 500 to 300 level.

Considerable oxide ore is said to have been found in the Blackhawk mine in the Castle district.

Shipping of Montana ores by rail to Duluth or other Lake Superior ports and thence by water to Buffalo or Cleveland offers a possibility of lower freight rates than the present method of direct rail shipment to consuming points.

NEW MEXICO

During 1928, 2,627 long tons of manganese ore, averaging about 47 per cent manganese, was shipped, compared with 2,190 tons, averaging 45 per cent or more, during 1927. Ferruginous manganese ore shipments decreased from 56,624 tons, averaging 12 to 15 per cent

⁵ Blumenthal, E. L., Proc. Am. Manganese Producers Association, September 10-11, 1928, p. 24.

manganese, in 1927, to 36,250 tons, averaging 10 to 15 per cent manganese, in 1928. Shipments of manganiferous iron ore in 1928 amounted to 19,081 tons, 11,629 tons less than in 1927. The active mines in New Mexico in 1928 included the Silver Spot and the Kirchman (both operated by the Colorado Fuel & Iron Co.) and the Boston Hills group of the Manganese & Fluorspar Producers Corporation and the Manganese Valley mine in Grant County and those of the American Mining Co. and the Luna Manganese Co., in Luna County.

The Silver Spot during the year carried out a large development program that included diamond drilling. The richer portions of the area have been developed by means of a series of flat dipping (25° pitch) adits that branch from a central adit. Some of these extend to an inclined depth of 600 to 800 feet and to a vertical depth of 90 to 140 feet at the face. A hoist and drag line pull the cars out of the mine after they have been loaded by automatic mucking machines. Development work will be continued in 1929, and it is hoped by the operators that with added equipment the output will be increased. Plans call for an output of 9,000 tons a month and the employment of 100 men during 1929. The ore thus far developed averages 9 to 11 per cent manganese, 33 to 35 per cent iron, 0.015 per cent phosphorus, 7 per cent silica, and 2 to 3 per cent alumina. Haulage costs from the mine to Pueblo, Colo., are \$3.60 to \$4 per ton. The average gross value of the ore is about \$15 a ton, f. o. b. mine. The developed reserve is claimed to be around 500,000 tons and the probable ore 1,000,000 tons, with a large tonnage of possible ore.

The Manganese Valley mine continued to ship concentrates during 1928 and practically completed a second unit of its concentrating plant, a unit designed to handle the screenings stored from operations of the first unit but also equipped to handle raw ore if necessary. It is expected that with the completion of this second unit the plant capacity will be doubled, so that about 40 tons of concentrates can be produced daily if this amount can be marketed. In the mine development work proceeded, and the results indicate a larger possible and probable reserve of concentrating ore than was anticipated at first. Most of this work was done along the south tunnel, where several hundred feet of drifting, crosscutting, raising, and winze sinking were done. A few winzes were sunk to a depth of 80 feet below the present main tunnel level. The plans for 1929 call for a second tunnel level, some 80 feet below the present workings, to connect with the new winzes. Two winzes were sunk from the north tunnel, and drifting was done along the main fracture from the bottom of the winzes. This new level when completed will be used as the main haulage level; it has the same elevation as the head of the mill.

The ore thus far encountered may be divided roughly into two main classes—ore containing 40 to 50 per cent manganese and concentrating ore containing 20 to 40 per cent. In addition, a considerable tonnage of ore running under 20 per cent manganese is amenable to concentration and sorting. Exact data on reserves are not available, but according to the lessee, R. H. West, there are 100,000 tons of proved ore, 300,000 tons of probable ore, and perhaps as much as 1,000,000 tons of possible ore. It is said that this tonnage only includes ore running 30 to 45 per cent manganese, 1.5 to 3.5 per cent iron, 0.02 per cent phosphorus, 5 to 8 per cent silica, and 1.25 per cent

alumina. The principal minerals include pyrolusite and psilomelane, calcite, siderite, and traces of lead, zinc, and silver minerals. Some believe that silver-lead or zinc-silver-lead ores may be encountered below the water level.

The ore is trammed to a bin at the mill, where a separation of coarse ore and waste is made. Material under 6 inches is delivered to a sorting screen, the fines from which are sent to a revolving screen for further classification. The oversize is passed to a jaw crusher. The fines are separated in the revolving screen into four classes: Under $\frac{1}{8}$ inch, from $\frac{1}{8}$ inch to $\frac{1}{4}$ inch, from $\frac{1}{4}$ inch to $\frac{1}{2}$ inch, and from $\frac{1}{2}$ inch to $\frac{3}{4}$ inch. The $\frac{1}{2}$ to $\frac{3}{4}$ inch size is added to the crusher product and the aggregate sent to jigs for washing and classification in a small drag classifier. The plant has a concentrating ratio of around 2 or $2\frac{1}{2}$ to 1. The concentrates are hauled several miles by truck to the Southern Pacific Railroad for shipment to eastern consuming centers. The cost of mining, milling, and transportation to the consuming center was \$18 to \$18.50 a ton. The detailed costs are as follows:

Mining-----	\$3. 30	Jigging-----	\$0. 61
Mucking-----	. 63	Tailings disposal-----	. 16
Tramming-----	. 70	Ore transportation to the	
Hoisting-----	. 39	railroad-----	. 74
Water-----	. 24		8. 23
Steel sharpening-----	. 26	Freight on ore to eastern points	9. 95
Lighting-----	. 10		18. 18
Transportation to mill-----	. 27		
Crushing-----	. 29		
Sorting-----	. 54		

The Luna Manganese Co., occupying the ground north of and adjacent to the Manganese Valley mine, has carried out an extensive prospecting and development campaign with very satisfactory results. Ore was developed to a depth of some 500 feet at the main shaft and for several hundred feet along the fracture both north and south of the shaft, on four levels. The vein appears to be widening in depth, and it is believed that the aggregate tonnage of the property will exceed original expectations. The Luna company is planning to construct a concentrator that will handle as much as 100 tons of ore a day when ultimate capacity is reached. Development work is being started on a fracture several hundred feet east of the main fracture and late in 1928 showed favorable indications. The ore is similiar in character to that being obtained from the Manganese Valley mine.

SOUTH DAKOTA

Interest has been aroused by the discovery of a low-grade manganese deposit extending over wide areas near Chamberlain, S. Dak.⁶ The manganese occurs in nodular form in a bed of hard shale. Upon exposure to the air the shale disintegrates rapidly, permitting separation of the nodular material, which is reported to contain 8 per cent iron, 16 per cent manganese, 0.50 per cent phosphorus, 16 per cent silica, 2.7 per cent alumina, 16 per cent lime, 1.8 per cent magnesia, 0.05 per cent sulphur and 10 per cent moisture. Loss on ignition is 26 per cent. It is claimed that an acre of uneroded ground will contain around 5,000 tons of the nodular manganese-bearing material.

⁶Engineering and Mining Journal, Extensive Manganese-Bearing Lands at Chamberlain, S. Dak.: Vol. 127, pp. 840-841, May 25, 1929.

The deposits lie along the Missouri River, outcropping on the east bank in Hughes, Hyde, Buffalo, Brule, and Charles Mix Counties and on the west bank in Gregory, Lyman, and Tripp Counties. The showings extend out from the Missouri along its numerous tributaries within an area of approximately 56,000 acres. The Pierre shales (Cretaceous) contain layers of manganiferous material that weathers out on the surface as the overlying softer clay matrix is eroded away. The "ore" has been described as of marine origin and made up of highly fossiliferous, noncrystalline carbonates of manganese, iron, calcium, and magnesium. The material when fresh is gray but it turns black when exposed to the atmosphere; exposed areas thus show "black spots." The material would require beneficiation, and it has been suggested that the Bradley-Fitch process might be suitable for such beneficiation.

TENNESSEE

Shipments of ore containing over 37 per cent manganese amounted to 55 long tons in 1928, compared with 498 tons during 1927. The shipments of ferruginous manganese ore amounted to 718 tons in 1928, compared with 487 tons in 1927. Practically all of the ore shipped came from the Carter and Watauga Valley districts in Carter County.

VIRGINIA

Shipments of manganese ore, containing over 35 per cent manganese, amounted to 3,812 long tons in 1928, compared with 3,212 tons in 1927. Of the 1928 shipments, 3,071 tons was metallurgical and 741 tons was chemical ore, whereas in 1927, 2,583 tons of the ore shipped was metallurgical and 629 tons chemical. Shipments of ferruginous manganese ore amounted to 105 tons in 1928, compared with 1,029 tons in 1927. No shipments of manganiferous iron ore were reported in 1928, compared with 177 tons shipped in 1927. Practically all of the chemical ore comes from Frederick County.

The Hy-Grade Manganese Co. has been conducting a large development campaign at its Mineral Ridge and Powell's Fort properties during recent years and has been experimenting with various beneficiation methods. This company reports that it has done 5,000 feet of development work, and claims that it has several hundred thousand tons of ore that will yield around 200,000 tons of concentrates averaging 45 to 47 per cent manganese and that the ore in place will run about 25 per cent manganese. The product of the mill is said to be suitable for use in the ceramic and metallurgic industries. The proposed new plant is designed to produce daily 100 tons of concentrate running 45 per cent manganese.

The Virginia Manganese & Mining Co., the Dunn Manganese Co., Faulkner & Hayton, and Salyer & Danner produced ore from the Flat Top (Stange) mine, at Crandon, in 1928; the property yielded more than 2,000 tons of high-grade ore during the year.

Ore was shipped in 1928 from the Riverheads district by the United States Manganese Corporation.

The Dunn Manganese Co. shipped ore from its Nobusiness mine. A small quantity of high-grade ore is reported to have been shipped from the Braun mine, 8 miles east of Bland, and small quantities were produced from mines at Hiawasse, Sutor, and Louisa.

Five thousand feet of drilling has been contracted for on the Old Dominion and part of the old Crimora properties, a few miles east of Crimora; work was in progress at the end of the year. In May, 1929, about 40 holes were reported, and development appeared to be satisfactory. The ore occurs mainly as psilomelane in masses and in disseminated layers or lenses in the Shady limestone and the Watauga shale. The ore contains little phosphorus but in places is relatively high in silica. Some of the beds drilled recently indicate 30 to 60 feet of concentrating ores. No production was made during 1928; further production will await the results of the exploration work now in progress. The old Crimora mine has in the past produced about 167,000 tons of marketable ore.

The Midvale mine near Midvale, Rockbridge County, is being opened up by the Midvale Manganese Co. This mine was productive during the war period, and present owners expect to place it on a producing basis soon.

WASHINGTON

Considerable development work was done during 1928 in the Crescent mine on the Olympic Peninsula, and a quantity of ore containing 15 to 50 per cent manganese and 13 to 28 per cent silica is reported to have been found. No shipments were made during 1928 because of high transportation costs and unfavorable market conditions.

It is rumored that a showing of ore running 40 to 45 per cent manganese has been discovered several miles west of the Crescent mine, but particulars are lacking.

IMPORTS OF MANGANESE ORE

The following table shows the imports of manganese ore into the United States from 1926 to 1928, by countries.

Manganese ore imported into the United States, 1926-1928

[General imports]

Country	1926		1927			1928		
	Manga- nese content (long tons)	Value	Ore (long tons)	Manga- nese content (long tons)	Value	Ore (long tons)	Manga- nese content (long tons)	Value
Africa (British):								
Union of South-----	6, 214	\$39, 683				5	3	\$73
West-----	48, 295	1, 088, 390	87, 230	42, 172	\$478, 214	24, 186	11, 712	145, 059
Brazil-----	130, 698	3, 428, 740	174, 026	78, 602	1, 584, 836	142, 300	64, 290	819, 615
Canada-----	200	9, 841	430	228	9, 660	3, 929	2, 234	101, 422
Chile-----	3, 942	100, 478	3, 206	1, 470	36, 054	9, 340	4, 423	118, 208
Cuba-----	(1)	224, 523	8, 976	4, 211	141, 836	3, 180	1, 556	60, 402
Germany-----	72	8, 976	65	37	4, 331	133	68	8, 007
India (British)-----	30, 596	899, 161	93, 017	47, 863	1, 185, 610	83, 600	43, 072	1, 037, 942
Italy-----	2, 920	76, 263						
Java and Madura-----	285	4, 159	1, 527	863	42, 276	1, 026	792	26, 580
Netherlands-----	12	1, 327						
Norway-----	1, 700	133, 528						
Soviet Russia in Europe-----	122, 345	5, 046, 176	253, 544	133, 159	5, 000, 279	159, 842	79, 529	3, 067, 259
United Kingdom-----	99	9, 886	46	25	3, 920	167	129	11, 382
	347, 378	11, 071, 131	622, 067	308, 630	8, 457, 016	427, 708	207, 808	5, 395, 949

¹ The imports from Cuba are recorded as 14,112 tons of ore; manganese content not shown.

² Exclusive of the manganese content of Cuban ores.

The imports of manganese ore in 1928 totaled 427,708 long tons (containing 207,808 tons of manganese), valued at \$5,395,949, compared with 622,067 tons (containing 308,630 tons of manganese), valued at \$8,487,016, in 1927, decreases in 1928 of 31 per cent in quantity of ore, 33 per cent in manganese content, and 36 per cent in total value. Russia, Brazil, British India, and British West Africa, in the order named, were the principal countries exporting to the United States in 1928; they contributed 96 per cent of the total ore imported. Imports of ore from each of these countries decreased materially in 1928; those from British West Africa and Russia decreased 72 and 37 per cent, respectively. Less important sources of imports in 1928 were Chile, Canada, and Cuba. Imports from Chile and Canada showed substantial increases in 1928, but those from Cuba fell off about two-thirds.

The decrease in imports of manganese ore into the United States in 1928 was due in part to withdrawals from consumers' stocks and in part to the increased utilization of lower grade ores.

The following tables show the nationality of bottoms carrying manganese ore into the United States in the calendar years 1927 and 1928.

Nationality of bottoms carrying manganese ore into the United States and per cent of total carried by each, 1927-28

Nationality of bottoms	1927	1928	Nationality of bottoms	1927	1928
United States.....	24.7	37.2	Greek.....	1.2	2.7
Brazilian.....	2.5	-----	Norwegian.....	2.9	2.0
British.....	46.9	39.4	Swedish.....	2.5	-----
Danish.....	4.3	3.2	Other.....	.7	1.3
Dutch.....	1.2	.4			
French.....	10.4	7.6		100.0	100.0
German.....	2.7	6.2			

It is noteworthy that in 1928 the quantity of ore imported in American bottoms increased materially, whereas that carried in British decreased. German bottoms appear to have replaced the Swedish. Danish, French, and Norwegian bottoms carried materially less in 1928 than in 1927, and Brazilian and Swedish carried none in 1928.

Nationality of bottoms carrying manganese ore into the United States, 1927-28, in long tons¹

Country of origin	Flag	1927	1928
Brazil.....	United States (Independent).....	92,050	124,950
	Brazilian.....	15,700	-----
	British.....	45,950	63,200
	Dutch.....	6,750	-----
	Norwegian.....	-----	50
	Swedish.....	8,400	-----
		168,850	188,200
Chile.....	United States (Independent).....	2,000	1
	Norwegian.....	1,016	1,401
	Panaman.....	4,400	6,231
		7,416	7,633

¹ Division of Statistics, Bureau of Research, U. S. Shipping Board, C. D. S. No. 1239, May 9, 1929. Subject to revision. These figures include ore held in bonded warehouses and not classed as ore imported for consumption; they may include some ferruginous manganese or manganiferous iron ores. Probably some of the surplus over imports for consumption was reexported.

Nationality of bottoms carrying manganese ore into the United States, 1927-28, in long tons—Continued

Country of origin	Flag	1927	1928
Cuba	United States (Independent)	1,243	384
	British	1,186	625
	Danish	4,600	
	Dutch		900
	Norwegian	2,070	36
	Panaman		263
		9,099	2,208
Jamaica	Honduran		70
Dominican Republic	British		40
Guatemala	Honduran	43	
England	United States (United States Shipping Board)	5,033	7,931
	United States (Independent)	3,500	11,033
	British	2,574	4,988
		11,107	23,952
Norway	United States (Independent)	1,600	
	Danish	1,800	3,850
	Norwegian	3,500	8,791
		6,900	12,641
Sweden	Swedish	10	
Germany	British		35
	German	11	61
	Norwegian	11	
		22	96
France	United States (United States Shipping Board)	41	93
Italy	United States (Independent)		117
	Italian		151
	Norwegian		382
	Spanish	189	224
		189	874
Union of Soviet Socialist Republics (Black Sea).	British	133,393	51,663
	Danish	21,377	13,178
	French	66,677	39,675
	German	17,343	32,394
	Greek	7,403	14,372
	Norwegian	11,765	
		257,958	151,282
Algeria	British		5,350
	Swedish	7,641	
		7,641	5,350
Gold Coast	United States (United States Shipping Board)	7,512	
	British	63,095	25,076
		70,607	25,076
Nigeria	do		4
Australia	United States (United States Shipping Board)		4,500
India	do	35,425	31,170
	United States (Independent)	9,476	14,250
	British	53,200	52,600
		98,101	98,020
Java	do	542	
	Dutch	868	1,059
		1,410	1,059
Atlantic Canada	United States (Independent)		1,500
	British		3,536
			5,036

Nationality of bottoms carrying manganese ore into the United States, 1927-28, in long tons—Continued

Country of origin	Flag	1927	1928
Summary	United States (United States Shipping Board).....	48, 011	43, 694
	United States (Independent).....	109, 869	152, 235
	Brazilian.....	15, 700	
	British.....	299, 940	207, 117
	Danish.....	27, 777	17, 028
	Dutch.....	7, 618	1, 959
	French.....	66, 677	39, 675
	German.....	17, 354	32, 455
	Greek.....	7, 403	14, 372
	Honduran.....	43	70
	Italian.....		151
	Norwegian.....	18, 362	10, 660
	Panaman.....	4, 400	6, 494
	Spanish.....	189	224
	Swedish.....	16, 051	
		C39, 394	526, 134

MARKETING OF MANGANESE ORE

The following is taken from a report by Furness.⁷

During the past 10 years it has become evident that the consuming countries draw their requirements of manganese from a greater number of sources than was evidenced in the past. This has been in part due to the desire of the manufacturers of ferromanganese to obtain a variety of ores from which an economic furnace mixture could be obtained. From the preceding table it will be seen that the Indian manganese ores, the washed Russian ores, and the Gold Coast ores will give a 50 per cent manganese content or better, while the Brazilian ores contain a lesser amount. Whatever value might accrue on account of the high manganese content in the Indian, Russian, and Gold Coast ores is more or less offset by the comparatively high content of iron, and for this reason the Brazilian ore is more desirable for the manufacture of ferromanganese. Ores from the four sources mentioned can be mixed readily in proportions which will enable the manufacturer of ferromanganese to make a mixture which will offset the disadvantages which might accrue by the use of any one of them. The following statement illustrates the elements to be considered in order that an economic blending might result:

High manganese content.....	Russian washed ore.
Low phosphorus content.....	Brazilian or Gold Coast ore.
Low iron content.....	Russian or Gold Coast ore.
Low silica content.....	Brazilian or Gold Coast ore.
Low moisture content.....	Indian ore.
Good structure.....	Do.

Manganese ore is purchased by the chemical trade on the basis of dioxide content. The manganese dioxide content varies in the commercial ores from 60 to more than 90 per cent. By far the larger part of manganese utilized in the chemical industry is required by the battery trade. In this use it is not the metallic manganese that is desirable, but the amount of available oxygen contained in the mineral. Pyrolusite, on account of its high dioxide content, is the mineral which usually supplies this industry. Theoretically, the amount of available oxygen in this mineral is 18.39 per cent. The physical quality of porosity largely governs the merchantability of the ore. The mineral should be sufficiently porous to allow free percolation of the acid through it but of such a density as to prevent crumbling. In any case it is quite impossible to lay down specifications for chemical ores utilized in the battery industry, since it is necessary to find out by trials whether an ore having a correct chemical composition is suitable from the physical point of view. The larger part of the pyrolusite now entering world's commerce is derived from the Caucasus, Russia; the Gold Coast, Africa; Philipsburg, Montana; Java, Netherland East Indies; and India,

⁷ Furness, J. W., *The Marketing of Manganese Ore: Trade Inf. Bull.* 599, Bureau of Foreign and Domestic Commerce, 1929, pp. 23-24.

not only in the mineral pyrolusite, but also as psilomelane. With the exception of the Philipsburg district, Montana, the chemical ores from the countries mentioned are required to contain not less than 78 per cent manganese dioxide. Those of the Philipsburg area are merchantable at from 68 to 72 per cent dioxide. Objectionable impurities are iron, copper, nickel, or cobalt. In England and European countries the present specifications call for at least 80 per cent MnO_2 (minimum available oxygen 14.72 per cent), less than 1 per cent of iron, and less than 0.05 per cent of copper, nickel, or cobalt.

The glass industry requires manganese dioxide ore relatively free from iron, containing not less than 52 per cent manganese and a dioxide content of at least 80 per cent. Iron oxide must not exceed 1 per cent. For this trade selected lump pyrolusite is ground fine enough to pass through a 16-mesh sieve.

LOW-GRADE MANGANIFEROUS RESOURCES

Manganese constitutes so considerable a part of the earth's crust that its minerals are found almost everywhere throughout the world. The United States is no exception. In addition to its relatively few high-grade deposits, manganese mineralization, varying from what may be regarded as low-grade ore to rock carrying some manganese, is known to occur in most of the States and probably could be discovered in all of them.

Carbonate ores, which consist largely of rhodochrosite but some of which contain appreciable amounts of rhodonite (manganese silicate), occur in substantial quantities in Montana, Massachusetts, California, and Colorado. The straight carbonate ores can be subjected to a roast that drives off the carbon dioxide, thus increasing the manganese content. This process is being worked successfully at Butte, Mont., where an ore containing 37 per cent manganese is roasted to a product containing over 56 per cent. When rhodonite is present in the ore, this process is not suitable because of the silica content of the final product. It is believed that ores of this kind will have to be treated chemically. The Bureau of Mines⁸ has conducted preliminary experiments with rhodochrosite-silica ores, using flotation, gravity, and magnetic concentration, and has obtained results which justify the more intensive work now in progress.

The manganiferous iron ores of the Cuyana range, Minnesota, constitute another important manganese resource. They contain 3 to 20 per cent manganese but are usually high in phosphorus and silica. The reserves of this ore are reckoned as many millions of tons. Some of it is now utilized for making manganese pig iron, but most of the lower-grade material is sold simply as iron ore. The Bureau of Mines, in cooperation with the University of Minnesota, has conducted extensive research into the recovery of the manganese from these ores in the blast furnace, but as yet the economic feasibility of such recovery has not been established.

At Chamberlain, S. Dak., it has been discovered recently that a very extensive bed in the Pierre shale contains nodules consisting of iron and manganese carbonates. These nodules are said to assay 16 per cent manganese and also 16 per cent silica. The silica must be removed or reduced in quantity by chemical methods, and a hydrochloric acid leaching process has been proposed, the economic feasibility of which has not yet been shown by large-scale operations.

⁸ De Vaney, F. D., and Coghill, W. H., Preliminary Ore Dressing Tests to Recover Manganese in Rhodochrosite Ores: Repts. of Investigations, Serial 2902, Bureau of Mines, November, 1929.

A large deposit of low-grade manganese ore has been located near Las Vegas, Nev., where the owners estimate that there are several million tons of material averaging 10 per cent manganese, with fairly high silica. Thus far the property has produced no ore for market, but considerable exploration has been undertaken during the past year.

In the Appalachian region of Virginia and Tennessee psilomelane and wad are found embedded in residual clays. The size of the oxide particles varies from very small to rather coarse. The larger-size material may readily be separated mechanically, but special treatment is required for separation of the fine material from the clay matrix. Great effort has been made in the study of this problem, and some fairly satisfactory results have been obtained without, however, yet rendering these ores generally available.

The Bureau of Mines has recently announced, as the result of work at the Mississippi Valley Experiment Station at Rolla, Mo., that psilomelane can be separated by flotation methods. Tests of other manganese oxides have been made, but less favorable results appear to have been obtained thus far. The Southern Appalachian ores require preliminary desliming in some instances to remove the limonite present; one of these ores yielded an 80 per cent recovery with a rejection of 94 per cent of the insolubles. It was also found that calcite, if present, floats with the psilomelane.

Recent tests by the Bureau of Mines in cooperation with the University of Missouri resulted in the following conclusions⁹ concerning the beneficiation of oxidized manganese ores by magnetic separation of roasted jig concentrates.

Some of the oxides of manganese have their impurities in the form of a physical mixture of iron oxide grains carrying the greater part of the impurities. When the ore is so constituted, a reducing roast will magnetize the iron oxide so that a low-intensity magnet will remove it and leave a clean concentrate of manganese ore. By this method some of the ores too high in iron to be used to make ferromanganese may be brought up to ferro grade.

The Dupont laboratories have recently developed a solution that has a density between those of the manganese oxides and the clayey gangues and that appears to offer a possible mode of attack on the problems of concentrating some of the Appalachian ores, but as yet no large-scale tests have been made to determine the economic usability of the method.

Among the chemical processes developed that involve use of a solvent is the Bradley process, in which the manganese is leached from the ore by ammonium sulphate. Other processes use a variety of solvents, including hydrochloric acid. Sulphidizing has been suggested and tested. In the laboratory experiments some of these processes have been successful in removing the phosphorus and silica and in resulting in a product that contains as high as 63 to 68 per cent manganese and 6 to 8 per cent iron.

To summarize the situation with respect to the development of the low-grade manganese ores in the United States: It appears that considerable technical advance has been made in beneficiation and that several processes that will produce a high-grade product have been devised. However, to date, only one of these processes has

⁹ De Vaney, F. D., and Coghill, W. H., Beneficiation of Oxidized Manganese Ores by Magnetic Separation of Roasted Jig Concentration: Repts. of Investigations, Serial 2936, Bureau of Mines, May, 1929, 4 pp.

been tried in large-scale operations—the successful roasting of rhodochrosite ores in the Butte district. It is not known whether the other processes proposed will be able to produce their final product under present market conditions, which, after all, is the vital question involved.

FERRO-ALLOYS

About 95 per cent of the manganese consumed in the United States is used in the manufacture of steel, the principal base alloys being ferromanganese and spiegeleisen. There is considerable manganese in many varieties of steel, including spring steels, plate steels, structural bar types, rail steels, and various steels used in the manufacture of wheels, tires, axles, armor plate, etc. Formerly manganese steels containing 1 to 1.5 per cent manganese were classed as good-grade Bessemer steel, but recently they have been classified as alloy steels and have been put on the market under various trade names. Such steels have excellent tensile strength and ductility, with high resistance to abrasion, and are used extensively in caterpillar shoes, truck wheels, and other appliances where relatively low cost and high quality are required. A manganese steel containing 12 to 14 per cent manganese is used in castings for ball mills, pulverizing machinery, and rock-crusher jaws because of its resistance to impact wear and of its hardness. Manganese is also an important constituent of nickel and molybdenum steels. Molybdenum steels usually contain 0.2 to 0.4 per cent molybdenum and 1 to 1.5 per cent manganese. Nickel-manganese steel usually contains approximately 1 per cent nickel, 1 to 1.5 per cent manganese, and 0.3 to 0.4 per cent carbon. The nickel adds ductility and toughness but increases the cost.

PRODUCTION OF FERROMANGANESE AND SPIEGELEISEN

Ferromanganese and spiegeleisen shipped from furnaces in the United States 1919-1928

Year	Ferromanganese		Spiegeleisen	
	Long tons	Value	Long tons	Value
1919.....	198, 255	\$27, 093, 816	90, 855	\$3, 965, 754
1920.....	1276, 594	41, 840, 690	103, 672	5, 289, 049
1921.....	1111, 374	13, 654, 800	169, 230	2, 838, 692
1922.....	1161, 612	10, 673, 638	70, 253	2, 162, 836
1923.....	226, 365	23, 853, 313	134, 086	4, 547, 113
1924.....	1232, 821	23, 533, 668	76, 179	2, 354, 731
1925.....	1254, 005	26, 006, 439	95, 890	2, 407, 226
1926.....	330, 070	31, 711, 871	82, 982	2, 016, 048
1927.....	291, 056	27, 243, 489	80, 892	1, 986, 188
1928.....	310, 122	29, 199, 990	116, 911	2, 802, 108

¹Includes a small quantity of silicomanganese.

²Includes a small quantity of silicospiegel.

IMPORTS AND EXPORTS OF FERROMANGANESE AND SPIEGELEISEN

Imports.—The ferromanganese imported for consumption contained 48,844 long tons of metallic manganese in 1928, compared with 36,400 tons in 1927 and 47,768 tons in 1926. Imports of spiegeleisen in 1928 decreased 30 per cent compared with 1927.

The following table shows the ferromanganese and spiegeleisen imported for consumption in the United States from 1919 to 1928.

*Ferromanganese and spiegeleisen imported for consumption in the United States'
1919-1928*

Year	Ferromanganese		Spiegeleisen	
	Long tons	Value	Long tons	Value
1919.....	33,022	\$4,283,541	27	\$1,018
1920.....	59,254	7,775,278	5,234	277,900
1921.....	9,077	888,419	307	10,472
1922 (Jan. 1-Sept. 21).....	72,136	6,125,469	3,899	268,135
1922 (Sept. 22-Dec. 31).....	122,871		4,252	
1923.....	191,066	8,357,023	4,668	165,791
1924.....	145,270	3,844,474	7,433	235,566
1925.....	162,970	6,033,147	1,090	39,841
1926.....	147,768	4,410,142	8,783	256,714
1927.....	136,400	3,553,465	7,529	220,979
1928.....	148,844	4,899,374	5,260	147,406

¹ Figures prior to Sept. 22, 1922, represent gross weight of the ferromanganese, but since that date represent the manganese content only.

Practically all of the ferromanganese imported came from Canada, Norway, and the United Kingdom. The cheaper methods employed in these countries are giving them an advantage in the market.

The following table shows the ferromanganese imported into the United States in 1927 and 1928, by countries.

Ferromanganese imported into the United States, 1927 and 1928, by countries

[General imports]

Country	1927		1928	
	Manganese content (long tons)	Value	Manganese content (long tons)	Value
Canada.....	17,923	\$2,171,589	19,026	\$2,495,743
France.....	411	79,842	354	63,777
Germany.....			23	3,477
Italy.....	23	3,212	611	95,492
Norway.....	6,724	537,406	11,896	934,793
Sweden.....	25	4,909	43	5,073
United Kingdom.....	8,912	608,037	15,567	1,207,830
	34,018	3,404,995	47,550	4,806,185

The following statement shows the ferromanganese imported into the United States in 1928 by ports of entry.

Manganese content (long tons)		Manganese content (long tons)	
Maryland.....	14,416	Philadelphia.....	1,707
Buffalo.....	9,548	Washington (State).....	998
New Orleans.....	6,838	New York.....	926
Michigan.....	6,551	Galveston.....	49
Ohio.....	2,950		
San Francisco.....	1,808		47,550
Los Angeles.....	1,759		

Maryland (Baltimore) received nearly 30 per cent of the total imports in 1928, Buffalo 20 per cent, and New Orleans and Michigan each 14 per cent, leaving 22 per cent for the other ports. An interesting feature is the importation of 4,565 tons through Pacific ports in 1928 for use in the western steel plants.

Manganese alloys imported into and made from domestic and imported ores in the United States, 1922-1928, in long tons¹

	1922		1923		1924		1925		1926		1927		1928	
	Alloy	Manganese	Alloy	Manganese	Alloy	Manganese	Alloy	Manganese	Alloy	Manganese	Alloy	Manganese	Alloy	Manganese
Ferromanganese:														
Imported.....	100,725	80,580	113,833	91,066	56,588	45,270	78,713	62,970	59,710	47,768	45,500	36,400	61,055	48,844
Domestic production ²	150,010	117,836	251,938	196,844	211,965	165,776	259,780	205,046	318,062	232,066	294,991	232,900	319,770	251,400
From domestic ore ³	2,547	2,017	13,070	10,008	7,352	5,600	14,910	11,592	13,495	10,541	10,037	7,472	18,850	14,036
From imported ore ³	147,463	115,819	238,868	186,836	204,613	160,176	244,870	193,454	304,567	241,525	284,954	225,428	300,920	237,364
Total.....	250,735	198,416	365,771	287,910	268,553	211,046	338,493	268,016	377,762	299,834	340,491	269,300	380,825	300,244
Ratio (per cent) of manganese in ferromanganese of domestic origin to total manganese in ferromanganese made and imported.....	1.0			3.5		2.7		4.3		3.52		2.77		4.67
Number of plants making ferromanganese.....	6		12		11		8		8		7		7	
Spiegeleisen:														
Imported.....	8,151	1,630	4,668	934	7,433	1,487	1,090	218	8,783	1,757	7,529	1,506	5,260	1,052
Domestic production ²	72,974	11,668	129,683	20,410	107,067	17,731	65,739	12,491	74,581	14,717	100,314	20,400	99,517	19,200
From domestic ore ³	70,374	11,365	126,424	20,026	103,617	17,306	65,759	12,491	74,096	14,627	97,337	19,834	99,517	19,200
From imported ore ³	2,600	303	3,259	384	3,450	425			485	90	2,977	566		
Total.....	81,125	13,298	134,351	21,344	114,500	19,218	66,849	12,709	83,364	16,474	107,843	21,906	104,777	20,252
Ratio (per cent) of manganese in spiegeleisen of domestic origin to total manganese in spiegeleisen made and imported.....	85.5			93.8		90.1		98.3		88.79		90.54		94.81
Number of plants making spiegeleisen.....	4		7		6		2		2		5		4	
Total available supply of metallic manganese as alloys.....	211,714		309,254			230,264		280,725		316,308		291,206		320,496
Percentage of available supply of manganese in—														
Ferromanganese and spiegeleisen imported.....		38.9		29.8		20.3		22.5		15.66		13.02		15.57
Ferromanganese made from imported ore.....		54.7		60.4		69.6		68.9		76.36		77.41		74.06
Spiegeleisen made from imported ore.....		1.1		1.1		2.2		2.4		3.03		2.57		4.38
Ferromanganese made from domestic ore.....		.9		3.2		2.4		4.1		3.33		2.57		5.99
Spiegeleisen made from domestic ore.....		5.4		6.5		7.5		4.5		4.62		6.81		10.37
Ferromanganese and spiegeleisen made from domestic ore.....		6.3		9.7		9.9		8.6		7.95		9.38		10.37
Spiegeleisen made and imported.....		6.3		6.9		8.3		4.5		5.21		7.52		6.32
Total open-hearth and Bessemer steel.....	33,228,281		44,383,745		37,476,940		44,758,450		47,626,547		44,260,062		50,734,151	

¹ Quantity made.² Partly estimated.³ Table prepared by H. W. Davis, of the Bureau of Mines.

The following table shows the production and imports of ferromanganese and manganese ore during the last seven years and the duties collected on the imported material:

Ferromanganese and manganese ore produced in and imported into the United States under the tariff act of 1922, in long tons

Year	Ferromanganese			Manganese ore		
	Domestic ship-ments	Imports	Duty col-lected	Domestic ship-ments	Imports	Duty col-lected
1922-----	161, 612	¹ 100, 725	² \$962, 037. 45	13, 404	¹ 425, 000	² \$405, 977. 60
1923-----	226, 365	¹ 113, 833	3, 834, 392. 70	31, 500	¹ 419, 000	1, 659, 638. 40
1924-----	232, 821	¹ 56, 588	1, 905, 643. 65	56, 515	¹ 505, 000	4, 780, 832. 00
1925-----	254, 005	¹ 78, 713	2, 652, 841. 80	98, 324	¹ 615, 000	6, 078, 352. 00
1926-----	330, 070	¹ 59, 710	1, 822, 746. 00	46, 258	¹ 738, 000	7, 935, 729. 60
1927-----	291, 056	¹ 45, 500	1, 526, 508. 60	44, 741	622, 067	6, 723, 964. 80
1928-----	310, 122	¹ 61, 055	2, 056, 776. 90	46, 860	427, 708	6, 006, 694. 40

¹ From Sept. 22, 1922, to Dec. 31, 1926, the Bureau of Foreign and Domestic Commerce reported only the manganese content of ferromanganese and manganese ore imported; since 1927 the bureau has reported the gross weight of the ore but only the manganese content of the ferromanganese. This figure is a Bureau of Mines estimate of the gross weight of ore or alloy imported.

² Tariff became effective Sept. 22, 1922; shipments and imports cover entire year.

Exports.—Exports of ferromanganese and spiegeleisen in 1928 amounted to 9,440 long tons, or nearly six times the quantity exported in 1927.

The following table shows the ferromanganese and spiegeleisen exported from 1919 to 1928.

Ferromanganese and spiegeleisen exported from the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919-----	2, 999	\$445, 840	1924-----	3, 165	\$92, 421
1920-----	3, 454	642, 570	1925-----	5, 496	160, 568
1921-----	690	100, 474	1926-----	693	44, 111
1922-----	¹ 1, 396	¹ 84, 562	1927-----	1, 641	61, 793
1923-----	4, 295	151, 224	1928-----	9, 440	232, 990

¹ Composed of 1,107 tons of ferromanganese, valued at \$76,822, and 289 tons of spiegeleisen, valued at \$7,740; not separately classified for other years.

FERROMANGANESE PRICES

According to the Iron Trade Review, the fluctuation in price of ferromanganese delivered at Pittsburgh in 1928 (\$104.79 to \$109.79) was less pronounced than in 1927 when the average monthly price ranged from \$94.79 to \$104.79. Early in 1928 the price appeared to be stationary at \$104.79 but shifted to \$108.19 in May and to \$109.79 in June, and remained at \$109.79 during the rest of the year. The stability of these prices for the given periods is probably due to the custom of large consumers of contracting for a five or six months supply, at a stipulated price, delivered at the furnace. Spot prices are apt to show more variation, as they apply usually to smaller lots sold at less regular intervals. According to the American Metal Market and the Iron Age, the average price f. o. b. furnaces was \$100 at the beginning of the year, shifted to \$105 on May 10, and ended the year at \$105; the average for the year was \$103.21.

The following table shows the quoted prices of ferromanganese, spiegeleisen, and manganese ore from 1923 to 1928.

*Prices per long ton of ferromanganese, spiegeleisen, and manganese ore in the United States, 1923-1928*¹

Month	Ferromanganese (80 per cent) (delivered at Pittsburgh) ²					
	1923	1924	1925	1926	1927	1928
January.....	\$109.79	\$113.79	\$116.79	\$119.79	\$104.79	\$104.79
February.....	112.29	112.29	119.79	119.79	104.79	104.79
March.....	120.79	112.29	119.79	102.29	104.79	104.79
April.....	124.79	112.29	119.79	92.79	104.79	104.79
May.....	129.79	112.29	119.79	92.79	98.54	108.19
June.....	129.79	112.29	119.79	92.79	94.79	109.79
July.....	122.29	110.79	119.79	92.79	94.79	109.79
August.....	122.29	98.79	119.79	92.79	94.79	109.79
September.....	114.79	97.79	119.79	92.79	94.79	109.79
October.....	112.79	104.79	119.79	99.79	94.79	109.79
November.....	113.79	107.29	119.79	104.79	94.79	109.79
December.....	113.79	109.79	119.79	104.79	103.42	109.79

Month	Spiegeleisen (20 per cent) (at producers' furnaces)					
	1923	1924	1925	1926	1927	1928
January.....	\$34.90	\$39.00	\$32.00	\$34.00	\$37.00	\$32.00
February.....	35.75	39.00	33.00	34.00	37.00	32.00
March.....	37.25	38.00	33.00	34.00	37.00	32.00
April.....	39.25	36.00	33.00	34.00	37.00	32.00
May.....	43.00	36.75	33.00	34.00	35.50	32.00
June.....	46.00	36.00	32.00	34.00	34.80	32.00
July.....	45.00	35.00	31.50	34.00	34.00	33.00
August.....	45.00	32.50	32.25	34.00	33.35	33.00
September.....	43.50	32.00	33.00	34.00	33.00	33.00
October.....	40.00	31.00	33.00	34.00	30.15	33.00
November.....	39.00	31.75	34.00	38.75	30.00	33.00
December.....	38.00	31.00	34.00	37.00	31.00	34.00

Month	Manganese ore (50 per cent) (duty paid, North Atlantic ports) ³					
	1923	1924	1925	1926	1927	1928
January.....	\$29.45	\$31.20	\$32.20	\$30.70	\$30.70	\$30.20
February.....	29.45	32.70	32.70	30.70	30.70	30.20
March.....	31.70	32.20	33.20	30.70	30.70	30.20
April.....	33.20	32.20	33.20	30.70	30.70	30.20
May.....	32.70	32.20	32.70	30.70	30.70	30.20
June.....	32.95	31.70	32.20	30.70	30.70	30.20
July.....	32.95	30.70	32.20	30.70	30.70	30.20
August.....	32.95	30.20	32.20	30.70	30.70	30.20
September.....	31.70	30.20	31.70	30.70	30.70	30.20
October.....	31.70	30.20	31.70	30.70	30.70	30.20
November.....	31.70	31.70	31.70	30.70	30.70	29.20
December.....	31.70	32.20	31.70	30.70	30.70	29.20

¹Iron Trade Review.

²Beginning with Sept. 22, 1922, a duty of 1½ cents a pound of contained manganese was placed on ferromanganese imports.

³Beginning with Sept. 22, 1922, a duty of 1 cent a pound was placed on the metallic content of imported manganese ore. This amounts to \$11.20 a ton on 50 per cent ore.

The following table shows the London quoted prices for ferromanganese, during 1928, by months.

London quoted prices per long ton of ferromanganese in 1928

Month	Home price f. o. b. plant ¹			Home price f. o. b. plant ²			Export price f. o. b. plant ¹			Export price f. o. b. plant ²			Export price c. f. f. Atlantic seaboard ¹		
	£	s	d	£	s	d	£	s	d	£	s	d	£	s	d
January.....	13	10	0	13	10	0	13	0	0	12	10	0	20	10	0
February.....	13	10	0	13	10	0	13	0	0	12	10	0	20	10	0
March.....	13	10	0	13	10	0	13	5	0	12	16	0	20	10	0
April.....	13	10	0	13	10	0	13	5	0	13	6	3	20	10	0
May.....	13	10	0	13	15	0	13	5	0	13	7	6	20	10	0
June.....	13	10	0	13	15	0	13	5	0	13	7	6	21	10	0
July.....	13	15	0	13	15	0	13	7	6	13	7	6	21	10	0
August.....	13	15	0	13	15	0	13	10	0	13	7	6	21	10	0
September.....	13	15	0	13	15	0	14	10	0	13	13	7½	21	14	0
October.....	13	15	0	13	15	0	14	10	0	14	0	0	21	14	0
November.....	13	15	0	13	15	0	14	10	0	14	0	0	21	13	3
December.....	13	15	0	13	15	0	14	10	0	14	0	0	21	13	0

¹ Iron and Coal Trades Review, weekly quotations.

² Mining Journal (London), weekly quotations.

The decrease in prices of manganese ores in 1928, caused in part by the reentrance of Russian ores at reduced rates during the last five months of the year, apparently had little influence on the price of ferromanganese in the United Kingdom. German prices remained constant at around £15 during the year. The freight rates on manganese ore from Calcutta and Bombay to Dunkirk and Antwerp were somewhat unsettled, ranging from 17½ to 18s. in January to 14½ to 15s. in the middle of the year and again to 17½ to 18s. in November and December. The rate to Dunkirk is slightly higher than that to Antwerp, and the rate to United Kingdom ports is about 6d. more than to Antwerp. Rates from Bombay are 6d. to 1s. less than from Calcutta. Possibly the increasing freight rates toward the end of 1928 had some effect on the increasing London ferromanganese prices.

CONSUMPTION OF ORE, ETC., IN ALLOYS

The production of ferromanganese in 1928 amounted to 319,770 long tons containing about 251,400 tons of metallic manganese, or an average content of 78.62 per cent manganese; in the production of this ferromanganese there were used 566,859 long tons of foreign manganese ore, 37,827 tons of domestic manganese ore, 23,159 tons of iron ore and manganiferous iron ore, and 8,395 tons of cinder, scale, and scrap. During 1927, 294,991 tons of ferromanganese was produced containing about 232,900 tons of metallic manganese, or an average of about 78.95 per cent manganese; in the production of this ferromanganese there were used 564,725 long tons of foreign manganese ore, 25,298 tons of domestic manganese ore, 12,735 tons of iron ore and manganiferous iron ore, and 8,570 tons of cinder, scale, and scrap. Domestic manganese ores used for ferromanganese amounted to 6.3 per cent of all manganese ores so used in 1928, compared with 4.3 per cent in 1927. The quantity of manganese ore used per ton of ferromanganese made decreased from 2 tons in 1927 to 1.891 tons in 1928, a result of improved metallurgical processes rather than of increased manganese content of the ores. In 1925 only about 80 per cent of

the manganese content of the ores used in the manufacture of ferromanganese was recovered, whereas in 1928 the recovery averaged about 85 per cent.

*Manganese ore and other metallic materials consumed and ferromanganese produced in the United States, 1921-1928*¹

Year	Materials consumed (long tons)				Ferromanganese produced			Manganese ore used per ton of ferro-manganese made (long tons)
	Manganese ore		Iron and manga-niferous iron ores	Cinder, scale, and scrap	Long tons	Manganese con-tained		
	Foreign	Domestic				Per cent	Long tons	
1921-----	208,376	17,839	143	2,092	104,129	76.17	79,319	2.172
1922-----	335,165	1,804	-----	5,252	150,010	78.55	117,836	2.246
1923-----	538,280	26,790	498	6,945	251,938	78.13	196,844	2.243
1924-----	443,260	20,133	909	4,434	211,965	78.21	165,776	2.186
1925-----	519,139	34,942	4,949	11,072	259,780	78.93	205,046	2.133
1926-----	619,898	36,309	8,064	5,122	318,052	79.25	252,066	2.063
1927-----	564,725	25,298	12,735	8,570	294,991	78.95	232,900	2.000
1928-----	566,859	37,827	23,159	8,395	319,770	78.62	251,400	1.891

¹Table prepared by H. W. Davis, of the Bureau of Mines.

Of the 37,827 long tons of domestic manganese ore and 566,859 tons of foreign manganese ore consumed by manufacturers of ferromanganese in the United States in 1928, Brazil supplied 38.49 per cent, Russia 36.70 per cent, India 16.98 per cent, Africa 4.42 per cent, Cuba 2.52 per cent, and Chile 0.89 per cent. During 1928, 116,592 long tons of ferruginous manganese ore and manganese iron ore from foreign sources were consumed in the manufacture of pig iron, ferromanganese, and, to a smaller extent, in silicomanganese and silicospiegeleisen. This ore was obtained as follows: 65,621 tons from Africa, 20,353 tons from Brazil, 13,314 tons from Australia, 15,617 tons from Spain, and a little from the Sinai Peninsula. Some ore containing over 5 per cent manganese was probably imported but was classed as iron ore.

*Foreign manganese ore used in manufacture of ferromanganese in the United States, 1926-1928, in long tons*¹

Source of ore	1926	1927	1928
Africa.....	42,692	41,470	25,039
Brazil.....	237,358	245,485	218,181
Chile.....	5,653	3,746	5,118
Cuba.....	18,372	9,408	14,280
India.....	31,667	78,548	96,232
Porto Rico.....	1,202	1,666	-----
Russia.....	282,954	184,402	208,009
	619,898	564,725	566,859

¹Table prepared by H. W. Davis, of the Bureau of Mines.

SILICOMANGANESE AND SILICOSPIEGEL

The Bureau of Mines is not at liberty to publish figures covering the production of these special alloys in 1928. The output in 1927 was 3,173 long tons, valued at \$301,321, compared with 2,183 tons, valued at \$354,364, in 1926. The chapter of this series for 1927 contained a description of these alloys.

MANGANIFEROUS ZINC RESIDUUM

Manganiferous residuum, from zinc roasting in the United States, shipped in 1920-1928, in long tons

1920-----	133, 602	1925-----	147, 937
1921-----	12, 627	1926-----	179, 926
1922-----	81, 333	1927-----	(¹⁰)
1923-----	132, 801	1928-----	171, 107
1924-----	119, 457		

MANGANIFEROUS SILVER ORE

*Manganiferous silver ore shipped from mines in the United States, 1919-1928, in long tons*¹

Year	Arizona	Colorado		Montana	Nevada	New Mexico
		For fluxing	For other purposes			
1919-----	1, 964	29, 769	11, 055	-----	77, 815	250
1920-----	345	34, 670	11, 056	-----	95, 142	541
1921-----	-----	10, 819	924	-----	14, 871	300
1922-----	-----	13, 951	-----	6, 656	-----	8, 764
1923-----	-----	10, 376	18, 348	3, 596	28, 571	-----
1924-----	-----	4, 488	30, 949	5, 607	16, 710	-----
1925-----	-----	11, 366	7, 352	-----	16, 168	-----
1926-----	-----	6, 656	2, 925	-----	11, 051	-----
1927-----	-----	1, 029	26, 828	-----	2, 161	-----
1928-----	-----	48	18, 516	-----	1, 602	-----

¹ All used for fluxing except that from Colorado designated "For other purposes."

FERRUGINOUS MANGANESE AND MANGANIFEROUS IRON ORES
UTILIZED IN MANUFACTURE OF MANGANESE PIG

Shipments of ore containing 5 to 10 per cent manganese from domestic mines amounted to 1,085,401 long tons, valued at \$2,645,165, in 1928, compared with 1,310,127 tons, valued at \$3,270,460, in 1927, and 835,412 tons, valued at \$1,934,381, in 1926. In addition, a large quantity of iron ore containing under 5 per cent manganese was shipped from the Lake Superior region; there has been a growing tendency on the part of manufacturers of pig iron to utilize such ores. The following table shows the shipments of ferruginous manganese and manganiferous iron ores from the Cuyuna range during the last nine years.

¹⁰ Bureau of Mines not at liberty to publish figures.

CUYUNA RANGE SHIPMENTS

Ferruginous manganese and manganiferous iron ore shipped from the Cuyuna district, Minnesota, 1920-1928, in long tons

Mine	Ore containing 10 to 35 per cent of manganese								
	1920	1921	1922	1923	1924	1925	1926	1927	1928
Algoma (Hoch)-----	15,115								
Arko-----	2,044								
Cuyuna Mille Lacs (Louise)-----					12,337	15,896	158,611	6,276	23,487
Ferro-----									
Gloria-----	738								
Hillcrest-----				430					
Hopkins-----					6,190	19,929			
Joan, Nos. 1 and 4-----	8,500								
Mahnomen-----	9,842		69,644	74,247	119,781	41,840			
Mangan, Nos. 1 and 2-----	10,979								(2)
Merritt, Nos. 1 and 2-----	33,239			24,387			4,148		
Milford (Ida Mae)-----	120,851								
Portsmouth-----			38,000						
Sagamore-----	163,904		197,449	154,570	21,607				
Sultana-----	138,312								
	293,524		305,093	253,634	159,915	77,665	158,759	6,276	3,487

Mine	Ore containing 5 to 10 per cent of manganese								
	1920	1921	1922	1923	1924	1925	1926	1927	1928
Cuyuna Mille Lacs (Louise)-----					9,737	165,142	12,046	218,791	205,103
Evergreen-----							6,054		7,881
Hillcrest-----		15,473	4,100						
Kennedy-----	9,511								
Mahnomen-Sultana-Hopkins ⁶ -----	81,066	41,057	110,590	282,883	128,967	206,155	384,753	374,307	340,630
Milford (Ida Mae)-----			870	77,300		205,050	202,154	149,034	161,432
Portsmouth-----	158,336		133,000	138,998					
Sagamore-----					222,823	165,062	194,451	192,467	309,965
	248,913	56,530	248,560	499,181	361,527	741,409	799,458	934,599	1,025,014

¹ According to the Iron Trade Review.

² Mangan included under "Cuyuna Mille Lacs (Louise)" for 1928.

³ According to the Lake Superior Iron Ore Association.

⁴ According to Skillings Mining Review.

⁵ Includes sinter.

⁶ Mahnomen prior to 1926.

FOREIGN RESOURCES

GENERAL STATEMENT

Complete data on the 1928 world production of manganese ore are not available. The total outputs in 1926 and 1927 were approximately the same at around 3,300,000 long tons. Of the 1927 total, British India produced 34 per cent, Russia 33 per cent, Gold Coast 12 per cent, Brazil 8 per cent, Egypt 5 per cent, United States 1.5 per cent, China 1.4 per cent, Spain 1.1 per cent, and other countries about 4 per cent. In 1927 India, Gold Coast, and Brazil increased their outputs, whereas the Russian production declined materially. In 1926 these countries ranked as follows: Russia 39 per cent, British India 31 per cent, Gold Coast 11 per cent, Brazil 8 per cent, Egypt 4 per cent, Spain, China, and the United States each 1.3 per cent, and other countries about 3 per cent. In 1928 Brazil increased her output 32 per cent, Egypt decreased 10 per cent, and preliminary figures indicate that the production of India was about the same as in 1927; data on Russia and the Gold Coast are incomplete.

The following tables show the production of manganese ore in the principal countries from 1924 to 1928, in metric and in long tons.

Manganese ore produced in the principal countries, 1924-1928, in metric tons

[Prepared by L. M. Jones, of the Bureau of Mines]

Country ¹	Percent- age of man- gane-se	1924	1925	1926	1927	1928
North America:						
Canada.....	35-50	530	---	---	---	349
Cuba.....	36-48	25,310	51,638	28,091	812	2,440
Mexico.....	40+	1,800	3,333	3,299	861	(?)
United States— Continental (exclusive of fluxing ore).....	35+	57,422	99,902	47,000	45,459	47,612
Porto Rico ²	35+	4,698	4,260	1,440	1,650	1,547
South America:						
Argentina ¹	---	---	---	140	230	141
Brazil.....	38-50	³ 159,229	331,827	260,536	273,494	359,651
Chile.....	40-50	4,243	11,062	11,134	7,688	(?)
Uruguay ²	---	---	---	39	---	---
Europe:						
Bulgaria.....	30-45	300	565	490	7	---
Germany.....	30+	3,554	144	25	30	(?)
Great Britain.....	30+	2,496	842	130	1,048	239
Greece.....	30+	5,726	4,303	6,348	8,283	1,080
Hungary.....	30	1,217	3,100	9,909	17,272	22,167
Italy.....	30-50	12,189	14,984	14,010	9,764	10,274
Portugal.....	38-60	³ 125	³ 11	---	491	(?)
Rumania.....	42	6,482	5,368	8,353	10,369	31,267
Russia ⁴	41-48	426,825	676,502	1,334,104	1,109,389	(?)
Spain.....	29+	20,840	36,072	44,947	36,870	13,704
Sweden.....	45+	10,881	10,941	15,258	16,823	15,790
Yugoslavia.....	42-45	4,570	2,716	1,244	1,971	2,660
Asia:						
China ¹	50-55	38,538	43,260	42,460	46,350	43,332
Cyprus.....	---	---	---	---	16	---
India— British.....	47-52	815,894	852,934	1,031,218	1,147,479	(?)
Portuguese ²	42-46	(?)	(?)	3,089	2,414	4,164
Japan.....	50+	7,585	12,040	15,209	27,560	(?)
Netherland East Indies.....	45-52	8,482	10,997	11,393	18,503	24,452
Turkey.....	---	43	107	78	1	61
Africa:						
Algeria ³	---	406	450	577	3,817	1,476
Egypt.....	30+	150,194	80,589	121,868	152,845	137,502
Gold Coast ¹	50+	259,441	362,897	377,284	409,658	(?)
Morocco (French) ²	50	---	679	306	2,696	2,144
Northern Rhodesia.....	41-50	---	---	---	705	1,821
Tunisia.....	30-43	3,220	1,655	1,550	2,056	2,200
Union of South Africa.....	40-60	930	471	835	1,300	---
Oceania:						
Australia— New South Wales.....	---	4,457	1,183	1,311	1,221	170
Queensland.....	50±	---	---	20	246	---
South Australia.....	45-56	321	---	---	---	---
Victoria.....	50±	---	---	---	15	---
Western Australia.....	47+	60	---	³ 83	³ 30	---
New Caledonia ¹	---	93	10	(?)	130	(?)
New Zealand ¹	52+	6	---	---	5	---

¹ In addition to the countries listed, Madagascar is reported to produce manganese, but statistics of annual output are not available. Czechoslovakia and France report a production of "manganese ore," but as it has been ascertained that the product so reported averages a content of less than 30 per cent manganese and therefore would be considered ferruginous manganese ore under the classification used in this report the output has not been included in the table.

² Data not available.

³ Exports.

⁴ Railroad shipments.

⁵ Year ended Sept. 30.

Manganese ore produced in the principal countries, 1924-1928, in long tons

[Prepared by L. M. Jones, of the Bureau of Mines]

Country ¹	Percentage of manganese	1924	1925	1926	1927	1928
North America:						
Canada.....	35-50	521				344
Cuba.....	36-48	24,910	50,823	27,647	799	2,401
Mexico.....	40+	1,772	3,280	3,247	847	(²)
United States—						
Continental (exclusive of fluxing ore).....	35+	56,515	98,324	46,258	44,741	46,860
Porto Rico ³	35+	4,624	4,193	1,417	1,624	1,523
South America:						
Argentina ⁴				138	226	139
Brazil.....	38-50	³ 156,715	326,585	256,420	269,174	353,970
Chile.....	40-50	4,176	10,887	10,958	7,567	(²)
Uruguay ⁵				38		
Europe:						
Bulgaria.....	30-45	295	556	482	7	
Germany.....	30+	3,498	142	25	30	(²)
Great Britain.....	30+	2,457	829	128	1,031	235
Greece.....	30+	5,636	4,235	6,248	8,152	1,063
Hungary.....	30	1,198	3,051	9,753	16,999	21,817
Italy.....	30-50	11,997	14,747	13,789	9,610	10,112
Portugal.....	38-60	³ 123	³ 11		483	(²)
Rumania.....	42	6,380	5,283	8,221	10,205	30,773
Russia ⁶	41-48	420,085	665,820	1,313,038	1,091,872	(²)
Spain.....	29+	20,511	35,502	44,237	36,288	13,488
Sweden.....	45+	10,709	10,768	15,017	16,557	15,541
Yugoslavia.....	42-45	4,498	2,673	1,224	1,940	2,618
Asia:						
China ³	50-55	37,929	42,577	41,790	45,619	42,648
Cyprus.....					16	
India—						
British.....	47-52	803,006	839,461	1,014,928	1,129,353	(²)
Portuguese ³	42-46	(²)	(²)	3,040	2,376	4,098
Japan.....	50+	7,465	11,850	14,969	27,124	(²)
Netherland East Indies.....	45-52	8,348	10,823	11,213	18,211	24,066
Turkey.....		42	105	77	1	60
Africa:						
Algeria ³		400	443	568	3,757	1,453
Egypt.....	30+	147,822	79,316	119,944	150,432	135,331
Gold Coast ³	50+	255,343	357,165	371,324	403,187	(²)
Morocco (French) ³	50		668	301	2,653	2,110
Northern Rhodesia.....	41-50				694	1,792
Tunisia.....	30-43	3,169	1,629	1,526	2,024	2,165
Union of South Africa.....	40-60	915	463	821	1,279	
Oceania:						
Australia—						
New South Wales.....		4,387	1,164	1,290	1,202	167
Queensland.....	50±			20	242	
South Australia.....	45-56	316				
Victoria.....	50±				15	
Western Australia.....	47+	59		³ 82	³ 30	
New Caledonia ³		92	10	(²)	128	(²)
New Zealand ³	52+	6			5	

¹ In addition to the countries listed, Madagascar is reported to produce manganese, but statistics of annual output are not available. Czechoslovakia and France report a production of "manganese ore," but as it has been ascertained that the product so reported averages a content of less than 30 per cent manganese and therefore would be considered ferruginous manganese ore under the classification used in this report the output has not been included in the table.

² Data not available.

³ Exports.

⁴ Railroads shipments.

⁵ Year ended Sept. 30.

NORTH AMERICA

CANADA

Manganese deposits occur between Tenny Cape and Walton, at New Ross (Lunenburg County), and on the Enon and Salmon Rivers in Nova Scotia; in Albert County, New Brunswick, and near the town of Kaslo, British Columbia. The New Ross district has very

high-grade pyrolusite ore which has been mined from time to time, and nearly 10,000 tons are said to have been shipped from this Province. Wad and psilomelane form the bulk of the Nova Scotia ores.

During 1928 Canada imported 106,443 short tons of manganese ore, valued at \$1,058,821, compared with 69,890 tons, valued at \$1,451,370, in 1927. Much of the ore imported is utilized in electric furnaces in the manufacture of ferromanganese, part of which is used locally, although a considerable quantity is exported to the United States and other countries.

WEST INDIES

Cuba.—The principal manganese ore deposits of Cuba are in the Provinces of Oriente and Pinar del Rio located, respectively, in the eastern and western extremities of the island. Some 24 mines were in operation during the World War, but only a few are now being worked because of inadequate transportation facilities. However, when the new national highway is completed this condition probably will be partly changed and new mines opened.

During 1928, 3,180 long tons of manganese ore was imported into the United States from Cuba, compared with 8,976 tons in 1927.

The recent purchase¹¹ by J. D. Maquire of an interest in the Magdalena manganese mine is expected to have a favorable effect on the Cuban industry. The purchase was made from Howard Trumbo, president of the Cuban Manganese Corporation, and the mine is to be operated under the joint ownership during 1929. The new corporation is constructing concentrating works at Cristo, near Santiago, and will employ a new process. It is said that when completed the plant will have a daily capacity of 500 tons of concentrates averaging about 54 per cent manganese and 4.35 per cent silica. Experiments indicate that the product of this plant will be more suitable for the blast furnace than the unbeneficiated ore.

Island of St. Martin.—Manganese ore deposits have been tested on the Island of St. Martin, Netherland West Indies, and the ore is said to average 45 to 46 per cent manganese, 5.06 per cent iron, 0.089 per cent phosphorus, and 9.55 per cent silica. Some samples are said to run as high as 53 per cent in manganese. Another area, about 2 miles away, is said to contain ore running 59 per cent manganese, 3.8 per cent iron, 5.4 per cent silica, and 0.16 per cent phosphorus. The deposits are near Philipsburg, on the Dutch portion of the Island of St. Martin, and are near enough to water to allow loading directly into ships. No shipments have been reported as yet.

SOUTH AMERICA

ARGENTINA

Manganese is reported to occur in a vein or mineralized layer in a schist underlying Tertiary deposits, about 10 kilometers west of La Quiaca by automobile road. The bed is 7 meters thick, dips 20° west, and was traced for $\frac{1}{2}$ kilometer or more to a point where it crosses into Bolivia. Analyses show that the ore will run around 52.5 per cent manganese and 3.9 per cent iron. No attempt has been made to exploit this deposit because of its relative inaccessibility.

¹¹ Skilling's Mining Review, Feb. 9, 1929, p. 15.

BRAZIL

According to official statistics Brazil exported 361,829 metric tons of manganese ore during 1928, as compared with 241,823 tons in 1927. From unofficial sources, believed to be reliable, the exports by countries to which consigned and the stocks are reported as follows:¹²

Manganese ore exported from and in stock in Brazil, 1927 and 1928, in metric tons

	1927	1928
Exports:		
United States.....	192,039	221,326
Belgium.....	41,142	68,557
France.....	33,113	34,952
Holland.....		14,225
Great Britain.....		8,190
Miscellaneous.....	274	1,423
	266,568	348,673
Stocks Dec. 31.....	35,260	46,238

The production in 1928 was 359,651 metric tons and was all obtained from Minas Geraes. According to statistics given by Burt, the United States took 72 per cent of the exports in 1924, 81 per cent in 1925, 91 per cent in 1926, 72 per cent in 1927, and 63 per cent in 1928. By far the larger part of the shipments to the United States in 1928 was from one company, a subsidiary of a large American company. The producing capacity of this company's mine is large enough to meet the company's needs, but during 1927 and the first part of 1928 production was limited to about 500 tons a day, and the balance of its requirements was imported from other sources.

The great manganese deposits of Brazil are located in the States of Minas Geraes, Matto Grosso, Bahia, Ceara, Rio Grande do Norte, and Maranhao, the mines in Minas Geraes being the most important. During 1928 practically the entire output from Brazil came from Minas Geraes, but several of the other areas were being actively developed. The following notes, unless otherwise indicated, are gleaned chiefly from a recent consular report on the manganese mining industry in Brazil.¹³

Minas Geraes.—The A. Thun & Cia (Ltd.), Cia Brasileira de Minas Santa Mathilde, Cia Meridional de Mineração, and Carlos Wigg are the principal operators. The principal mines operated by these companies are the Merid (Cia Meridional de Mineração); the Jurema-Michaela, Amaral, Paiva, Sabino, and Pequery (Santa Mathilde group); São Conçalo; Tripuhy; Agua Preta; Cocuruto (A. Thun & Cia (Ltd.)); and Usina Wigg. The following table shows number of employees, the reserves, and grade of ore at the most important mines.

¹² Burt, Joseph F., American Vice Consul, Rio de Janeiro, Brazilian Manganese Ore Exports During 1928: MS. Consular Rept. 300036, Jan. 19, 1929.

¹³ Cahn, Rudolf E., American Vice Consul, Rio de Janeiro, MS. Consular Rept., 293040, Oct. 24, 1928.

Most important manganese mines of Minas Geraes, Brazil

Mine	Number of employees	Ore reserves	Grade of ore
		<i>Metric tons</i>	<i>Per cent manganese</i>
Merid.....	500	2,500,000	42-50
Santa Mathilde.....	1,400	3,000,000	40-52
Usina Wigg.....	100	(¹)	48-52
Agua Preta.....	250	500,000	40-48
São Conçalo.....	200	400,000	40-48
Tripuhy.....	120	800,000	(²)

¹No data.²The product is ferruginous manganese ore containing 23 per cent iron and 25 per cent manganese.

The Merid mine, formerly known as the Morro da Mina, is at Queluz (near Lafayette) and is owned by the Cia Meridional de Mineração, a subsidiary of the United States Steel Corporation. Other mines at Queluz are the Santa Mathilde, Agua Preta, and São Conçalo. The Usina Wigg underground mines are at Usina and Burnier, and the Tripuhy is at Ouro Preto, near Rodrigo Selva.

A new organization, the South American Manganese Co., has been formed in London with a capital of £150,000 to purchase the freehold of 2,400 acres in the State of Minas Geraes and to develop manganese deposits thereon.¹⁴ The purchase price was fixed at £115,000, payable £20,000 in cash and the balance by the allotment of 95,000 shares credited as fully paid. A working capital of £25,000 is deemed sufficient by the directors, as they estimate the cost of the plant, buildings, railway stock, and equipment necessary to provide for an output of from 200 to 300 tons of ore per day should not exceed £15,000. It is estimated that production will begin within four months after the start of operations. The estimated profit on a 50,000-ton basis was put at £52,500 per year.

Matto Grosso.—Only one deposit has been exploited thus far in Matto Grosso, and this is in the Urucum Hills, 15 miles from Corumba. On January 3, 1925, the State is said to have signed an agreement with the Pimentel interests, owners of the Cia Mathilde, for an output of 50,000 tons to be reached at the end of three years. This company is locally known as the Empresa de Mineração and is said to be under Swiss and Belgian control. The company has 25,430 acres, and the reserves have been estimated at from 15,000,000 to 120,000,000 metric tons. The ore is said to contain from 43 per cent to as high as 53 per cent manganese.

Bahia.—There are two main deposits in Bahia, one near Nazareth in the All Saints Bay region and the other on the Este Brasileiro Railway between Jacobina and Bomfin. The ore in the former runs about 44 per cent metallic manganese and that in the latter is said to average about 52 per cent. The second deposit is owned by a French syndicate which produced in 1926 but which has been idle since. The Bahia region can not compete with the Minas Geraes deposits, which have the advantage of better transportation facilities and lower labor costs.

¹⁴ South African Min. and Eng. Journal, Oct. 20, 1928, p. 194.

The Northern & Eastern Trading Co. (Ltd.)¹⁵ has been organized recently and has acquired the right to work two groups of manganese mines in Bahia on a royalty basis; Humberto de Lima, the owner, is to receive 40 per cent of the net profits. It is said that the company is to make a down payment of £10,000 in cash and £30,000 in shares, should it exercise its option.

At a place called "Brejocatuaba,"¹⁶ in the municipality of Bomfin, an important manganese deposit has been discovered; plans are under way for the formation of a company to exploit the property.

Ceara.—At Cangaty on the Baturite Railway in Ceara, a deposit was discovered in 1928 which is said to be manganese and magnetic iron ore with spessartite garnet, silicates of aluminum, and silicate of manganese mixed with milky quartz, pyrolusite, and other manganese oxides. A large company is said to have been organized to exploit the deposits, and a smelter is planned at the port of Chaval (Ceara) for the treatment of the iron ores, which are 18 kilometers from the port. Rough preliminary estimates indicate a reserve of several million tons.¹⁷

Maranhao.—The deposits in Maranhao are in the municipality of Tury-Assu, 190 miles from Para and 150 miles from Sao Luis de Maranhao.

Goyaz.—It is reported that important manganese deposits have been discovered in the State of Goyaz on a ranch owned by Dr. Agenor Caldas, 6 kilometers from the village of Santa Luzia.¹⁸

Costs of labor, transportation, etc., in Brazil.—Labor in Minas Geraes costs the operator \$0.78 to \$0.84 for an 8-hour day, and there appears to be ample labor available except possibly during the coffee-harvesting season.

The Minas Geraes deposits lie along the Central of Brazil Railway, which delivers the ore to Rio de Janeiro for shipment to foreign countries. Until recently car shortages were troublesome, but in the last year notable improvement in service has been evident. Freight charges range from \$2.80 to \$2.90 a long ton for 41 to 50 per cent ore carried 500 kilometers, and in addition there are miscellaneous transportation charges amounting to \$0.12. The following table shows the freight charges effective during 1928.

Freight rates on manganese ore in Minas Geraes, Brazil, in 1928

Class of ore	Freight per long ton		10 per cent tax	
	Milreis	Equivalent in dollars ^a	Milreis	Equivalent in dollars ^a
50 per cent or over.....	26	\$3. 11	2. 6	\$0. 31
41.01 to 50 per cent.....	20	2. 39	2. 0	. 24
41 per cent or less.....	18	2. 15	1. 8	. 22

^a Average annual rate of exchange of a milreis in 1928 was 11.97 cents.

¹⁵ Engineering and Mining Journal, Sept. 15, 1928, p. 428.

¹⁶ Huhlein, Fred E., American vice consul, Rio de Janeiro, MS. Consular Rept. 288501, Aug. 28, 1928.

¹⁷ Woodford, Archer, MS. Consular Repts. 251716, June 25, 1927, and 254005, July 12, 1927, Pernambuco, Brazil.

¹⁸ Huhlein, Fred E., MS. Consular Rept. 292989, Rio de Janeiro, Oct. 15, 1928.

In addition to the above freight rates, there are other charges usually payable on shipments of manganese ores from the mine to export centers, which bring the total carrying charges on ore containing 41.01 to 50 per cent to approximately 23.6 milreis (\$2.82) per ton plus 1 milreis (\$0.12) per car.

In addition to the railroad charges, the State of Minas Geraes charges export tax as follows:

*State export tax rate on manganese ore in Minas Geraes, Brazil, in 1928, in milreis*¹

Class	February to September		October to December	
	Official value ²	Ad valorem tax	Official value ²	Ad valorem tax
Special—over 50 per cent.....	70	10.7	65	9.9
1st. A—49.01-50 per cent.....	50	6.2	45	5.6
B—48.01-49 per cent.....	47	5.7	42	5.1
C—47.01-48 per cent.....	44	5.3	39	4.7
D—46.01-47 per cent.....	41	4.8	36	4.2
2d. A—45.01-46 per cent.....	40	3.7	35	3.2
B—44.01-45 per cent.....	37	3.3	32	2.9
C—43.01-44 per cent.....	34	3.0	29	2.6
D—42.01-43 per cent.....	31	2.7	26	2.3
3d. A—41.01-42 per cent.....	30	1.9	25	1.6
B—40.01-41 per cent.....	27	1.7	22	1.4
C—39.01-40 per cent.....	24	1.5	19	1.2
D—38.01-39 per cent.....	21	1.3	16	1.0
Inferior—less than 38 per cent.....	20	1.6	15	.6

¹ 1 milreis is at present (October, 1928) equal to \$0.12.

² The official value is fixed by the State, at which time a table is issued showing the exact tax payable on each grade of ore.

³ 0.8 milreis from June to September, inclusive.

This tax is augmented by an additional tax as follows: Class I, 30 per cent; Class II, 25 per cent; Class III, 20 per cent; Class IV, 15 per cent; and Class V, 10 per cent. The average freight and tax charges are around \$3 to \$3.20 a ton from the mines to Rio de Janeiro.

In the State of Matto Grosso requirements with regard to taxes are incorporated into the contracts of the Urucum mines, which state that the concessionaire shall pay export taxes of 4, 6, or 8 per cent ad valorem for each ton of ore in accordance with the following schedule: On the basis of 60 milreis and under (4 per cent), from 60 to 100 milreis (6 per cent), and above 100 milreis (8 per cent).

CHILE

Manganese ore suitable for steel manufacture is being mined in the Las Cañas district,¹⁹ in Coquimbo Province. From 1885 to 1900 more than 500,000 tons of ore was exported from the ports of Carrizal and Coquimbo. This ore was mined in the Provinces of Atacama and Coquimbo, but by 1905 these deposits were inactive. In 1919 the W. R. Grace Co. reopened the mines in the Las Canas district, and during 1919 and 1920 some 12,000 tons was mined and exported to the United States. Part of this ore came from the La Liga district, near Pelicana. Poor market conditions during 1921 to 1923 caused a shut-down, but since 1924 the company has been operating steadily.

¹⁹ New York Times, May 13, 1928 (quotation from Grace Log, W. R. Grace & Co.).

The deposits of Coquimbo lie about 40 kilometers east and south-east of La Serena and extend over a length of 55 to 60 kilometers to the north and south, the continuity of the deposits being broken by barren areas. The town of Las Canas lies near the north end of the deposits. The mines are 12 to 16 kilometers northeast of Marquesa Station on the railroad running from Coquimbo and La Serena to Vicuña.

The principal mines in the Las Canas district are the Romero, Potosi, Mina Alta, Yeso, and the Talcuma, practically all of the present work being confined to the Romero. The ore beds dip from 0° to 15° into the hills, the ore being worked through inclined entries that follow the dip. The ore is very hard and requires drilling and blasting, which greatly increases mining costs, as the drilling at present is done by hand. It is carried to the surface in leather pouches on men's backs. The ore as broken in the Yeso and Potosi mines runs about 44.5 to 47.25 per cent and only a small amount of cobbing is required to raise the ore to a shipping grade. Mining is contracted on the basis of 48 per cent ore delivered at the bin. Haulage from the bin to the railroad is also contracted. Contractors are required to supply their own pack animals and packs. The ore is stock-piled at Coquimbo in piles ranging from 2,000 to 2,500 tons. The entire export goes to the United States through the ports of Baltimore, Hampton Roads, and Philadelphia.

The Corral Quemada district lies about 50 kilometers south of Las Canas. The ore shoots are said to be large, but the district is 30 kilometers from the railroad, and the costs of mining and transportation are prohibitive under present conditions. From 1883 to 1903 these deposits produced several hundred thousand tons.

URUGUAY

Manganiferous ore deposits have been discovered at Zapucay, in the Department of Rivera; the available reserve has been estimated at about 80,000,000 tons containing about 35 per cent iron, 23 per cent manganese, 9 per cent silica, 0.05 per cent sulphur, and 0.03 per cent phosphorus.

EUROPE

BELGIUM AND LUXEMBURG²⁰

Belgium and Luxemburg imported 267,115 metric tons of manganese ore in 1928, compared to 269,361 tons in 1927. The ore came mainly from British India, with smaller quantities from Russia and Brazil.

GERMANY²¹

German imports of manganese ore decreased from 373,183 metric tons in 1927 to 284,239 tons in 1928. The imports of ferromanganese decreased from 5,010 tons in 1927 to 4,369 tons in 1928. On the other hand, the exports of ferromanganese increased from 8,541 tons in 1927 to 18,005 tons in 1928. The imports of manganese ore came from the following countries.

²⁰ The Metal Bulletin, Feb. 19, 1929, p. 8.

²¹ Consular Rept. 303116 checks these figures roughly.

Manganese ore imported into Germany, 1927 and 1928, in metric tons

Country	1927	1928	Country	1927	1928
Russia.....	210,682	72,200	Netherland East Indies.....	6,232	12,769
India.....	76,657	126,593	Other.....	30,201	14,904
Egypt.....	46,841	29,962			
Brazil.....	2,570	27,811		373,183	284,239

The iron ores of the Westerwald, in the Vogelsberg and Taunus Mountains, of the East Rhine Provinces, are said to contain 17,000,000 tons of proved ore and 15,000,000 tons of probable and possible ore running 20 to 25 per cent iron and 20 to 24 per cent manganese. In the Siegerland district, southern Westphalia, there are 116,000,000 tons of proved iron ore reserves, 50,000,000 tons of probable ore, and 50,000,000 tons of possible ore running from 6 to 9 per cent manganese. The carbonate ores in the Spessart district contain 33 per cent iron and 8 to 16 per cent manganese.

GREAT BRITAIN

Great Britain imported 205,965 long tons of manganese ore in 1928 compared with 198,527 tons in 1927.

GREECE

The mining of manganese ore in Greece began about 40 years ago in Messinia, near the ancient city of Ithomi. After two years, however, operations ceased because of poor transportation facilities and of competition from the Russian Chiaturi deposits. In fact, all of the southwestern part of Greece, from the Olympia district down Cape Akritas, is manganiferous, but the impregnations are not high enough in grade to warrant exploitation under present market conditions. However, in Arcadia, in Messinia, and south on Lycodimo Mountain outcrops appear to justify the erection of washing plants, as is the case in Zerbissia (Messinia district) where the A. Despositos Co.²² is beginning to produce high-grade dioxide ore (87 to 90 per cent MnO₂).

Practically the entire manganese export from Greece now comes from the Islands of Melos and Andros and from the mines at Grammatiko near Marathon. Thirty years ago 15,000 tons a year was obtained from Grammatiko, but in recent years only about 1,500 tons has been produced annually.²³

The Bani mines on the Island of Melos are close to Cape Vani; the ores occur in Pliocene clays in the immediate vicinity of trachytic tuffs, from which, presumably, the ore solutions were derived. The main bed ranges from 2 to 6 feet in thickness, and the manganese content varies from 32 to 52 per cent. The ore is mined in large open-cut workings, and washing is accomplished in a small dressing plant using sea water. A small narrow-gage railway connects the mines with a small pier, where the ore is loaded and exported to England.

²² Panaghi Lykiardopoulo, Manganese Ore in Greece: Eng. and Min. Jour., July 7, 1928, p. 20.

²³ Mining Magazine (London), January, 1929, p. 17.

The Kokini mines on the Island of Andros, according to official statistics, made no production in 1925 and 1926, mined 40 tons in 1927, but had 3,000 tons in stock at the mines. In the extreme southwest of Greece there are small abandoned manganese mines at Saratzas, 4 miles west of Koroni. Manganese ores have been recorded from the Islands of Paros, Siphnos, Seriphos, Kimolos, Keos, and Mykonos, but those from Mykonos have been found too siliceous. Small amounts of manganiferous iron ore are produced at Laurium in Attica.

The following table²⁴ shows the quantity and grades of manganese ore produced in Greece in 1927.

Manganese ore produced in Greece in 1927

Company	Metric tons	Grade per cent Mn
La Société Minière "Bani Milos".....	6,695	26-32
George N. Georgiou.....	148	42
Société "Mines de Calamata".....	1,200	39.47
S. Couloumpini.....	200	
J. D. Kokinis.....	40	25-45

Manganiferous ores are common in Greece, especially near Spathi on the Island of Zea, where ores running 49 per cent iron and 22 per cent manganese are found.

ITALY

Italy produces only a small part of its requirements of manganese ore and is forced to import ore from India and Russia. According to *Relazione del Servizio Minerario, Ministero dell' Economia Nazionale*, Rome, the domestic production from 1925 to 1927 was as follows:

	Metric tons
1925.....	14,984
1926.....	14,010
1927.....	9,764

The principal mines are on the Island of Sardinia and in the Province of Liguria, the Sardinian deposits contributing the major part of the output.

FRANCE²⁵

France imported 738,226 metric tons of manganese ore during 1928, compared with 659,600 tons in 1927. The 1928 imports came from the following countries:

	Metric tons
British India.....	267,095
Russia.....	110,410
Gold Coast.....	78,442
Brazil.....	43,171
Asia (other).....	42,463
Spain.....	13,240
Miscellaneous.....	183,405
	738,226

The large importation of ore during the last few years has led to the belief in some quarters that France is building up a reserve stock

²⁴ Ministère de L' Economie Nationale, Statistique de l' Industrie Minière de la Grèce, 1927, Athens, 1928, p. 8.

²⁵ Iron and Coal Trades Review, Apr. 5, 1929, p. 500.

pile of manganese ore. C. M. Weld,²⁶ chairman of the subcommittee on manganese of the Mining and Metallurgical Society of America, is quoted as follows:

Furthermore, from a study of French imports of manganese ore, there is a very strong reason to suspect that the French have taken the leaf out of our book and have by now established their stock pile.

Further comments on the subject have been made by J. W. Furness,²⁷ of the Bureau of Foreign and Domestic Commerce, as follows:

Mr. Weld, our chairman, called attention to the imports of manganese ore by France during the past few years. It is of more than passing interest to note that in 1926 France imported upwards of 600,000 long tons of high-grade ore and is the second largest importer in the world. Her output of steel during that period was about 8,000,000 tons. Comparative 1926 figures for the United States show imports upwards of 730,000 tons of high-grade manganese ore and a steel output in excess of 47,000,000 tons, so the inference to which our chairman drew attention seems to be relatively correct, in that France has apparently taken a leaf out of the manganese report of your subcommittee.

During 1927 and 1928 France imported approximately 660,000 and 738,000 tons, respectively, of high-grade manganese ore and the steel output for the same years was 8,510,000 and 9,300,000 tons, indicating that the situation in these years was substantially the same as in 1926. Details as to the consumption of manganese per ton of average steel made in French metallurgical practice are not available to the writer. The ratio of high-grade ore imported to tons of steel produced in France in 1928 indicates about 75 pounds of manganese per ton of steel, whereas in the United States the latest figures indicate that about 14 pounds of metallurgical manganese is used to the ton of steel.

RUSSIA

In 1913 Russia produced about 56 per cent of the world output of manganese ore, whereas in 1927 only 33 per cent of the world total was credited to Russia. The ore is obtained from three districts: (1) The Nikopol district, on the banks of the Dnieper River, in Central Russia; (2) the Chiaturi district, in the Sharopan region of the Kutais Government in the Caucasus; and (3) the Ural region, near Bieloiretsk.

The following table shows the production of ore in the three producing Russian districts from 1922 to 1927:

Manganese ore produced in Russia in fiscal years ended September, 1922-1927, in metric tons^a

Fiscal year ended September 30—	Chiaturi (crude ore)	Nikopol (con- centrates)	Ural (crude ore)	Total (crude ore and con- centrates)
1922.....	31,040	21,622	8,683	61,345
1923.....	150,762	65,591	7,196	223,549
1924.....	320,123	100,033	6,669	426,825
1925.....	^b 497,899	175,571	3,032	676,502
1926.....	^b 848,447	478,318	7,339	1,334,104
1927.....	636,944	472,152	293	1,109,389

^a 1922-1926: Geological Committee of U. S. S. R., Ann. Rept. on Mineral Resources of U. S. S. R.: 1925-26, Leningrad, 1927, p. 373. 1927: Gornyi Zhurnal, vol. 104, No. 9, September, 1928.

^b Includes concentrates from dumps, as follows: 63,079 tons in 1925 and 77,705 tons in 1926.

²⁶ Weld, C. M., Domestic Situation in Manganese: Min. and Met. Soc. of America, Bull. 194, vol. 21, No. 2, March-April, 1928, p. 23.

²⁷ Furness, J. W., Domestic Situation in Manganese: Min. and Met. Soc. of America, Bull. 194, vol. 21, No. 2, March-April, 1928, p. 35.

Nikopol.—The mines of the Nikopol district formerly supplied the domestic demand, and before the revolution only about a third of the output was exported. For a period following the revolution practically all of the Russian product was sold abroad, but since 1925 the home demand has been resumed. The German firm, Rawack & Grünfeld, has reequipped the mines of Nikopol and has constructed plants to handle the ore, so that the production of this district has increased materially. According to the Iron and Coal Trades Review²⁸ the deposits in the Marganetz (Nikopol) contain about 100,000,000 tons of manganese ore averaging 48 to 50 per cent manganese, 2 to 3 per cent iron, 0.01 to 0.22 per cent sulphur, and 0.18 to 0.22 per cent phosphorus.

Of the output in 1926–27 (fiscal year ended September 30) the iron and steel works in southern Russia took about 35 per cent, about 40 per cent was exported, and the remainder was stocked. Until the German firm took over the operations the second and third grades of ore were not utilized.

Chiaturi.—The Chiaturi district has long been the most important producer in Russia, but as a result of war and revolution the production in 1922 was only a small fraction of the pre-war output. After 1922 production increased rapidly. On June 12, 1925, a concession for working these deposits was granted to the Harriman interests. Under the terms of the contract the Soviets reserved 15,000,000 tons of ore which they might work themselves. They also reserved the right to purchase at cost price all of the ore which might be required for Russian industry. Conservative estimates²⁹ place the reserves at around 100,000,000 tons of ore well suited, after washing, for the chemical and battery trades. The Harriman concession³⁰ is said to have employed several thousand people and to have produced 800,000 tons of ore to the end of 1927.

During the summer of 1928 the Harriman concession was relinquished and production was begun by the Soviet Trust. The Soviets are said to have guaranteed to return \$3,500,000 to the Harrimans over a period of years, and the Harrimans are to furnish engineering assistance and possibly part of the needed finances.

A recent summary of the causes of the failure of the Harriman concession was made in the Manchester Guardian,³¹ as follows:

While the recent dissolution by mutual agreement of the Harriman manganese concession (supposed to run for 20 years from the date of signature in 1925) was not accompanied by any definite accusations of bad faith from either side, the explanations for the failure of the concessionaire and by the Soviet Economic authorities naturally show a certain degree of variation. Representatives of the Harriman firm at various times have offered the following reasons for the failure of the concession to work satisfactorily:

1. After obtaining what was regarded in anticipation as practically a monopoly contract for the production and export of Russian manganese, the Harriman firm found itself handicapped by the very rapid development of the hitherto neglected manganese field in the vicinity of Nikopol, in southern Ukraine. With the technical cooperation of the German firm of Rawack & Grünfeld, the exports from Nikopol began to develop so rapidly that they competed with the Tchiaturi manganese on the European markets.

²⁸ Iron and Coal Trades Review, Mar. 23, 1928, p. 421.

²⁹ Buck, I. J., Georgian Manganese Regaining Its Old Standing in World Markets: Eng. and Min. Jour., vol. 125, June 23, 1928, pp. 1016–1017.

³⁰ Iron and Coal Trades Review, Jan. 10, 1928, p. 78.

³¹ The Commercial, Thursday, Jan. 10, 1929; Manchester Guardian, vol. 18, No. 447.

2. The Harriman firm was handicapped in its competition with Nikopol and other manganese exports because it was subject to a levy of \$3 a ton for manganese and for higher sums for other minerals.

3. The demand of the local trade unions for housing and other social welfare expenditures were excessive, and the local courts showed little disposition to protect a foreign concessionaire against demands of Russian (or Georgian) trade unions. Special complaint was made in regard to a case in which the dockers of Poti, the port of shipment of the Tchiaturi manganese, according to the Harriman version of the story, refused to abide by the terms of a collective agreement which their union had concluded.

4. A decree passed by the Soviet Government last March prohibiting the importation of roubles into the country greatly raised the working costs of the concession by making it impossible to continue the practice of buying roubles in near Eastern countries at rates considerably below the official one.

The Soviet authorities are always very sensitive to any criticism of their concessions or credit policies and the Soviet version of the failure of the Harriman enterprise has been set forth by V. Ksandrov, head of the main concessions committee. Mr. Ksandrov produces a series of facts and figures to prove that the unsatisfactory termination of the concession was primarily due to Mr. Harriman's policy of charging high prices for his manganese. This stimulated the development of the manganese resources even in expensive and otherwise unpromising fields, such as Gold Coast, where the production of manganese rose from 7,310 tons in 1921 to 450,000 tons in 1927.

British and American steel firms, alarmed at the menace of a monopolistic domination of the world manganese market, with consequent high prices, by the Harriman interests, sought manganese in India, Brazil, Egypt, and West Africa. As a result, instead of the limited production on which Harriman counted to ensure his policy of high prices, there was a glut of manganese on the world market, and the price per unit of metal, which was 23 d. in 1924, sunk to 16 to 17½ d. in 1928. Mr. Ksandrov argues that the more skillful maneuvering with prices on the part of the concessionaire would have warded off the Gold Coast competition.

In regard to other points of complaint, Mr. Ksandrov, as a revision of the concession agreement in August 1927, gave the Harriman representatives more favorable conditions regarding payment of labor, and cites a statement of December 1927, in which both sides professed to be satisfied with the situation of the concession in this respect.

Regarding the importation of currency which was made the final pretext for the annulment of the concession contract, Mr. Ksandrov raises the question whether a solid business firm should base its operations on currency speculation.

It is the writer's personal opinion that unfavorable conditions on the world manganese market constituted the basic factor in the breakdown of the Harriman contract. The dockers of Poti were doubtless annoying enough in their way; but this and other labor difficulties could, and most probably would, have been settled if the concession had otherwise shown profitable results.

The Soviet Government has now taken over the operation of the Tchiaturi manganese field and claims to have increased production substantially since Harriman's departure. That a state trust may not be required to pay the royalties exacted of Harriman, and that trade unions may prove less intransigent in relation to a foreign concessionaire, may stimulate the export of manganese from the region, especially as it is an interest of the Soviet economic policy to push export at almost any cost.

According to the Amtorg Review,³² the following has been the activity shown by the Soviet trusts:

The Soviet State Manganese Trust of the Georgian Republic, which was organized by the government after the Georgian Manganese Company (Ltd.) concession was liquidated, reports a steadily increasing output of manganese.

Eleven idle plants have already been put into operation by the newly organized trust and a number of other plants are being overhauled. While in August 1928 production of manganese ore amounted to 14,221 metric tons, from which 8,335 metric tons of washed ore were obtained; in November of the same year production of ore rose to 55,827 metric tons and of washed ore 28,987 tons. The total production for the four months, August-November, was nearly 125,000 tons. Exports from the Chiaturi mines were as follows: August, 23,360 tons;

³² Amtorg Economic Review, Apr. 1, 1929, p. 141.

September, 17,500 tons; October, 15,356; and November, 17,432 tons. The number of workers increased from 849 in August to 2,780 in November. The Soviet State Manganese Trust is working on plans for the construction of a large central concentrating plant, which will permit of greater efficiency in production.

The Soviets claim to have contracts for the delivery of 750,000 tons during 1929. Metallbörse³³ reports that the Russian Chiaturi deposits exported 500,000 tons during the fiscal year 1927-28 and the Manganexport (Berlin) has already booked 850,000 tons during 1928-29, but according to Metal Bulletin these figures represent the combined figures for Chiaturi and Nikopol. It is said that the Union of Socialist Soviet Republics has entered into an agreement with Rawack & Grünfeld, of Berlin, whereby that company will act as agent for the sale of Caucasian ore in continental Europe,³⁴ as well as that of the Nikopol deposits.

Urals.—The Ural region produces ore that runs about 40 per cent manganese, except that from the Bieloiretsk mine, of which the content is about 50 per cent. The Ural production is relatively unimportant. At Kutimshoje, in the north Urals, there are said to be nearly 600,000 tons of manganiferous iron ore, containing up to 20 per cent manganese. In the Troitsk district, Urals, there is a reserve of manganiferous iron ores running up to 16 per cent manganese.

Other regions.—Two beds of manganese ore containing 3,000,000 tons, averaging between 30 and 60 per cent, have been discovered in the north Caucasus.³⁵ The deposits are said to occur in Oligocene strata. A deposit has been located in Kuban Province³⁶ and is said to have 35,000,000 to 40,000,000 tons of reserves averaging 40 per cent manganese content or 14,000,000 to 16,000,000 tons of metallic manganese. The iron ores of the Kertch Peninsula contain 1.5 to 7 per cent manganese, and there is said to be a reserve of about 500,000,000 tons.

SPAIN AND PORTUGAL

Many of the iron ores of Spain are manganiferous. The deposits in the Sierra Morena are said to have a total reserve of nearly 200,000,000 tons of iron ores containing 2 to 11 per cent manganese. The deposits at Villaricos, in the Province of Almería, contain up to 8 per cent manganese. The Cartagena and Garrucha manganese iron ores contain 12.16 and 12.45 per cent manganese, respectively.

The Odemira or Thiago district in southwestern Portugal contains manganiferous iron ores running 20 to 50 per cent iron, 2 to 35 per cent manganese, 5 to 35 per cent silica, 0.05 to 0.35 per cent phosphorus, and 0.03 to 0.25 per cent sulphur. There are said to be about 10,000,000 tons of reserves.

ASIA

INDIA (BRITISH)

The production of manganese ore in India increased from 1,014,928 long tons, valued at £2,590,357 f. o. b. Indian ports, in 1926, to 1,129,353 tons, valued at £2,844,237 f. o. b. Indian ports,³⁷ in 1927.

³³ Metal Bulletin, Feb. 5 and Feb. 26, 1929.

³⁴ Iron and Coal Trades Review, Apr. 5, 1929, p. 500.

³⁵ Kolodzhazny, A. Ztschr. prakt. Geol. vol. 33, 1925, p. 167.

³⁶ Selsky, W. A., Rev. Univ. des Mines, ser. 7, vol. 13, No. 6, p. 280, Paris, 1927.

³⁷ Fermor, L. L., Records of the Geological Survey of India: Vol. 61, pt. 3, 1928, pp. 226-229.

The price of first-grade ore, c. i. f. United Kingdom, opened at 19.9d. in January, 1927, fell to 16.5d. in September, and recovered to 17d. in December, the average for the year being 18d. or about the same as in 1926. The following table shows the manganese ore production of British India in 1926 and 1927, by Provinces and districts.

Manganese ore produced in British India, 1926 and 1927, in long tons

Province and district	1926		1927	
	Long tons	Value f.o.b. at Indian ports	Long tons	Value f.o.b. at Indian ports
Bihar and Orissa:				
Gangpur State.....	10, 379	£26, 856	7, 960	£20, 928
Keonjhar State.....	23, 810	47, 322	51, 115	103, 721
Singhbhum.....	2, 473	6, 399	9, 970	26, 213
Bombay:				
Chhota Udaipur.....	10, 000	25, 500	11, 729	30, 398
Belgaum.....	4, 290	10, 100	4, 515	11, 871
North Kanara.....	2, 000	5, 175	4, 005	10, 530
Panch Mahals.....	57, 325	148, 328	78, 802	207, 184
Central India: Jhabua State.....	7, 969	16, 901	10, 510	22, 728
Central Provinces:				
Balaghat.....	336, 579	921, 385	313, 556	871, 424
Bhandara.....	152, 858	418, 449	130, 211	361, 878
Chhindwara.....	42, 242	115, 637	47, 264	131, 355
Jubbulpore.....	100	274	181	503
Nagpur.....	229, 586	628, 492	252, 637	702, 120
Madras:				
Bellary.....	8, 853	14, 054	6, 004	9, 782
Sandur State.....	77, 327	122, 757	138, 196	225, 144
Vizagapatam.....	21, 698	37, 339	31, 992	56, 386
Mysore State:				
Chitaldrug.....	1, 599	2, 645	4, 021	6, 819
Shimoga.....	23, 032	38, 099	23, 658	40, 120
Tumkur.....	2, 803	4, 645	3, 027	5, 133
	1, 014, 928	2, 590, 357	1, 129, 353	2, 844, 237

The increase in production in 1927 was shared by all of the Provinces except the Central Provinces and by nearly every district, the only decreases being in Gangpur State, in Bihar and Orissa, in the Bhandara and Balaghat districts of the Central Provinces, and in the Bellary district in Madras. The Keonjhar and Singhbhum districts in Bihar and Orissa increased substantially, and the Panch Mahals, in the Bombay Presidency, showed an increase to nearly 79,000 tons, the highest figure ever recorded. The Central Provinces decreased 17,500 tons from 1926, compared with an increase of 139,000 tons in 1926 from 1925. In Madras the output of Sandur State increased more than 60,000 tons, reaching 138,196 tons in 1927 and exceeding the previous record production of 1907 by 41,105 tons. The production in India in 1928 is said to have maintained the same rate as that in 1927, but no definite figures are yet available.

There is a steady domestic consumption of manganese ore at the various works of the three principal iron and steel companies.

The ore is used in the manufacture of steel and ferromanganese, and is also charged to the blast furnaces in the making of pig iron. The consumption in the local industries in 1927 was 39,065 tons, about 2,000 tons less than in 1926.

The exports of manganese ore in 1927 amounted to 843,821 long tons, compared with 613,536 tons in 1926 and 738,836 tons in 1925. Maximum exports (862,777 tons) were made in 1922.

The following table shows the exports of British India manganese ore in 1926 and 1927, by ports of shipment.

British India manganese ore exported from India, 1926-27, by ports of shipment, in long tons¹

Port	1926	1927
Bombay.....	222,371	249,360
Calcutta.....	291,745	418,173
Madras.....	9,800	13,910
Mormugão (Portuguese India).....	89,620	*162,378
	613,536	843,821

¹ Records of the Geological Survey of India, vol. 61, pt. 3, 1923, p. 229.

In addition, 2,376 tons of manganese ore produced in Portuguese India was exported.

The exports from British India ports ³⁸ amounted to 658,567 long tons in 1928, compared with 681,443 tons in 1927. The figures covering exports of British India ore from Portuguese India ports in 1928 are not yet available.

The Geological Survey of India ³⁹ in 1904 estimated that a production of 600,000 tons could be maintained for 30 to 40 years, about 50 to 75 deposits contributing to the total.

A new company, the East India Manganese, is said to have been organized with a capital of £140,000 to acquire certain deposits in Bihar and Orissa.

The following quotation from the annual report of the Central Provinces Manganese Ore Co. (Ltd.) indicates the conditions found during the year in India.

Your directors regret that the trading profit for the year under review shows a drop of £23,539 when compared with the year 1927. Conditions have been exceptionally difficult, but fortunately we had the benefit of forward contracts made at somewhat better prices than those which prevailed during the whole of 1928.

From the statistics available, we estimate that, although the steel production of the world increased during 1928 by some 7,000,000 tons, the export of manganese ore from producing countries dropped by about 400,000 tons. As there is no evidence to indicate that the percentage of manganese used per ton of steel is lower than in previous years, we are driven to the conclusion that makers of ferromanganese must have been carrying large stocks of ore or ferro.

The price per unit of metallic manganese dropped heavily during 1928 and still remains low. In August last, the Russian Government resumed control of the Caucasian deposits, which for some time previously had been worked by the Harriman Co. This had a disturbing effect on the price of ferro-making and second-grade ores, and, although we are still able to market our ferro ore at a small profit, we shall not be able to compete for the trade in the second-grade ores, used in enormous quantities for basic iron making, until we can persuade the Indian Railways to charge a substantially lower rate for carrying our mineral from the mines to the ports. We have fully stated our case to the railways concerned and have pointed out to them that we have a very large tonnage of second-grade mineral lying at our mines and sidings which we could readily sell in competition with Russian and other ores if the rate for carriage was reduced.

Until this question of railway freight is settled we have, as far as possible, stopped the production of second-grade ore, but at some of our mines second grade has to be won with the ferro-making ore, so that stocks which in more favorable circumstances would find an immediate sale are accumulating.

Since I addressed you last, our managing director has paid a visit of inspection to the mines, and you will be interested to hear some of the more salient points that arise in his detailed and interesting reports to the board.

³⁸ Accounts Relative to the Seaborne Trade and Navigation of British India, Monthly, 1928.

³⁹ Fernor, L. L., The Manganese Ore Deposits of India: India Geol. Survey, Mem., 1909, vol. 37, p. 457.

The Bombay Port Trust and the railway authorities were interviewed with the object of inducing them to reduce their charges.

The mines generally are in an excellent condition and the staff efficient under the able direction of Mr. Bartlett, the agent and general manager.

Considerable attention is being paid to the matter of housing the staff and workmen at the mines. Excellent permanent quarters are being built, and on all important mines well-equipped dispensaries in charge of assistant medical officers have been established. On several of the mines we have established schools which are attended by the children of our workpeople.

On one of our mines we have opened an Infant Welfare Center, with a trained nurse in charge, and if this proves to be a success similar centers will be established on our other important mines.

The new Tumsar Tirody branch of the Bengal & Nagpur Railway and the assisted sidings, on which we ourselves have spent over £50,000, were practically completed at the time of his visit.

This new branch taps the most important groups of our mines, which until now were served by a 2-foot gage tramway. There is little doubt that this group contains 20,000,000 tons of marketable ore.

Considerable expenditure has been incurred in equipping these mines so that they will be in a position to give large outputs, and the tonnage of ore that can be produced from them will be limited only by the amount that we are able to sell.

The present attitude of the Bengal & Nagpur Railway Co., however, in the matter of rates has unfortunately already compelled us to restrict production in the areas served by this branch.

According to Consul Jarvis,⁴⁰ the c. i. f. costs of Indian manganese ore are as follows:

As more than 60 per cent of the total output of manganese ore in British India is produced from the mines operated in the Central Provinces, this résumé of the c. i. f. costs at principal ports of delivery is based upon the cost of transporting a ton of ore from that region.

In 1925 mine operators in the Central Provinces computed the cost of producing a ton of manganese ore, including administration, at \$2.34. Labor conditions have not changed materially since that year. The Central Provinces Manganese Ore Co. (Ltd.), however, has recently entered upon a campaign to reduce the cost per ton by the introduction of modern mining methods.

In the past the larger part of the manganese ore shipped from the mines in the Central Provinces was transported to railroad by bullock carts. In recent years the Central Provinces Mining Co. has, in many cases, installed narrow-gage railways and aerial ropeways. In the spring of 1927 one of the largest producers in the State of Sandur installed an aerial ropeway which was largely instrumental in reducing the cost of transportation to railroad. At present the average cost of transporting 1 ton of ore from the mines to the railway is estimated at \$0.54, but this average is being rapidly reduced by the building of sidings or spur lines from the main line of the Bengal & Nagpur Railway.

In estimating the cost of placing a ton of ore at seaboard, an average cost for railway freight has been assumed, on a basis of weighted tonnage. Owing to port facilities, the larger part of India's shipments are made from Bombay and Calcutta, although they are more distant from the mines than Vizagapatam and Mormugao, where the manganese ore is lightered to the cargo vessels in the lack of loading equipment. The Central Provinces Manganese Ore Co., in collaboration with other shippers of merchandise and assisted by the British Indian Government, is improving the port facilities at Vizagapatam, and it is expected that this port will be open for traffic by the fall of 1932. Under present conditions the cost per ton for transportation from the Central Provinces to Bombay is reported to range from \$4.03 to \$5.18, and an average of \$4.41 has been estimated for transportation to either Bombay or Calcutta.

In recent years by far the larger part of the manganese ore exported from India has been shipped from Calcutta. The distances from the various mines in the Central Province mining district to Calcutta and Bombay are practically the same, but the average cost of handling a ton of ore is \$1.17 at Bombay and \$0.76 at Calcutta. At Vizagapatam the costs are higher on account of the difficulties of loading by surfboats (lighterage), and insurance on the ore is also greater since

⁴⁰ Jarvis, R. Y., C. I. F. Costs of Indian Manganese Ore: Commerce Repts., Oct. 29, 1928, pp. 293-294.

the lighters often are sunk. The costs at Portugese Mormugao are slightly higher than at Calcutta, but the rail costs are less as the deposits are situated nearer this port and, in addition, Mormugao is the only well-protected harbor on the west coast, with the exception of Bombay. Throughout India the average charge of agents for the handling of manganese at the various ports has been \$0.27 a ton.

The royalty to be levied on base metals in India is "2½ per cent on the sale value at the pit's mouth, or on the surface, of the dressed ore or metal, convertible at the option of the local government to an equivalent charge per ton, to be fixed annually for a term." This tax amounts to a charge of \$0.06 to \$0.09 a ton. In the native States royalties are based on tonnage, irrespective of price. In 1927, on a tonnage basis of 27,004 mined in the State of Mysore, the State collected in royalty \$7,572, or approximately \$0.28 a ton.

The following compilation shows present royalties computed in cents per ton:

	Cents per ton
Jhabna State.....	9
Mysore State (5 per cent on pit's mouth value, minimum).....	22
Sandur State.....	13
Vizianagram Samasthamum.....	9

In the early part of 1927 ocean freight rates for manganese ore were much higher than at the close of the year, and during 1928 they have declined steadily. In January, 1927, rates to ports in the United Kingdom were quoted at \$5.06 a ton and in the following December at \$4.44. The average rates for the year were \$4.70 a ton from Bombay and \$4.62 a ton from Calcutta; the approximate weighted average was \$4.84. During 1927 the rates from Indian ports to Antwerp were stabilized by agreement at \$3.84 a ton.

Ocean freight rates to United States ports depend largely upon negotiation and vary between rather wide limits. During 1927 the rate averaged about \$4.85; in January, 1928, it opened at \$4.86, and by September had decreased to \$3.63. During 1927 the agents of the American-Indian combination of lines shipped over 45,000 tons of ore from Calcutta, about one-half of the total exported to the United States that year, at a rate of \$5.46. In the present year this same combination quoted a rate of \$5.10 from January to June and for the second half of the year offered \$4.86.

The average value, c. i. f., of Indian manganese ore in London in 1927 was \$0.36 per unit for ore containing 48 per cent or more of manganese. The average price for the year of ore from the Central Provinces was \$18.23 a ton.

The estimated average cost of one ton delivered in London, 1927, was as follows:

[Mean—Calcutta and Bombay]

F. o. b.....	\$8. 53
Ocean freight.....	4. 66
Insurance (¾ per cent f. p. a.).....	. 01
Handling at district.....	. 97
Royalty.....	. 09
Total.....	14. 26

In this connection it is believed that when the new port of Vizagapatam is completed in 1931 or 1932 the c. i. f. cost will be somewhat lowered.

NETHERLAND EAST INDIES

The Netherland East Indies produced around 24,000 tons of manganese ore in 1928, all of which came from the Java mines of the Algemeene Industrieel Mjinbouw en Exportatie (familiarily known as A. I. M. E. M.). The company has increased its production regularly since 1921, and the production during 1927 and 1928 was nearly double that of the two previous years. The mines are in the residency of Djokjakarta. The ore is shipped from the West Coast port of Pjilatjop to Germany, Netherlands, Great Britain, and France. A new Diesel power plant was installed during 1928, and electrification of the Kliripan mine was completed; it is expected that these improve-

ments will result in increased production. The company earned \$1,194,000 during 1928.⁴¹

The following table shows the exports of manganese ore from Netherland East Indies, from 1926 to 1928, by countries.

Manganese ore exported from Netherland East Indies, 1926-1928, by destinations, in metric tons

Destination	1926	1927	1928	Destination	1926	1927	1928
Netherlands.....	2,918	4,615	2,638	United States.....	1,067	1,071	1,068
Great Britain.....	1,724	1,733	2,434	Japan.....	-----	1,706	1,443
Germany.....	2,654	4,257	4,693	Australia.....	-----	119	115
France.....	430	1,007	1,806		227	60	-----
Italy.....	1,731	107	107				
Denmark.....	473	610	515		11,224	15,285	14,899

Development was continued on the Javanese⁴² deposits, where reserves are estimated at 10,000,000 tons running about 45 per cent manganese.

PERSIA

The International Bergwirtschaft reports⁴³ a new discovery in Persia, as follows:

Between Kirman and Jesd beds of manganese ore and coal have been found. The reserve of manganese ore is said by the discoverer, Docter Böhne, to be around 14,000,000 tons.

TURKEY IN ASIA

A German company, the Sûdanatolische Bergbau-Aktiengesellschaft has been organized in Munich with a capital of 1,500,000 marks to acquire and develop mines in Turkey, particularly in southwestern Asia Minor.⁴⁴ The extent of the company's holdings is not known, but its activity is to be centered around Makri. The deposits are on the southern coast of Turkey, particularly at Yenidji-Kouy, at Karadji, and at Mendus-Dagh, all within a radius of 30 kilometers of Makri. Other deposits are at Buhush, 30 kilometers from Adalia. The German company has been installing machinery, and it is believed that the plants are about completed. Aerial tramways have been built in the Makri region and production is expected in 1929.

AFRICA

EGYPT

Sinai Peninsula—Prior to the development of the Gold Coast deposits in 1923 the Sinai Peninsula in Egypt was the most important producer of ferruginous manganese ore in Africa. During the past few years the annual output of Egypt has ranged from 80,000 to 150,000 long tons; 135,331 long tons was produced in 1928, or 10 per cent less than in 1927.

The Sinai Peninsula has large deposits of ferruginous manganese ore, lying about 15 miles from the port of Abou Zenima on the Red Sea, 70 miles south of Suez. The reserves are estimated⁴⁵ at 2,500,000 long tons of assured ore, 3,000,000 tons of probable ore, and 6,250,000

⁴¹ Baringer, T. C., American trade commissioner: Economic and Trade Notes 302-87297, Apr. 5, 1929.

⁴² Commerce Reports, Feb. 25, 1929, p. 488.

⁴³ International Bergwirtschaft, Jahrg. 3, No. 6, June, 1928, p. 117.

⁴⁴ Carrigan, John, jr. (U. S. Consulate, Smyrna, Turkey), MS. Consular Rept. 272106, Feb. 2, 1928.

⁴⁵ Becket, F. M., Mining and Metallurgical Society of America: Bull. 194, vol. 21, Apr., 1928.

tons of possible ore. The ore is said to contain 28 to 32 per cent metallic manganese (sometimes running as high as 35 per cent), about 25 per cent iron, and low phosphorus, silica, and alumina, and is said to occur in nearly horizontal beds ranging in thickness from 6 inches to 12 feet. The deposits are discontinuous over the area and variable in composition. There is practically no water at the mines; washing plants, however, are said to be unnecessary. The ore is mined either by the pillar-and-stull method or by longwall systems. Labor is plentiful and said to be amenable to training. The ore is transported from the mines about 5 miles by ropeway and 10 miles by rail to the seaport; there serious difficulties have been encountered because of exposure of the ships and docks to the sea.

Deposits of hematitic and manganiferous ores associated with limestone occur at Wadi Malha and Wadi Hallig. The ores vary from pure hematite to pure manganese dioxide and may be divided into two general classes, as follows: (1) 48 to 69 per cent iron and up to 6 per cent manganese, (2) up to 24 per cent iron and 18 to 60 per cent manganese.

GOLD COAST

Manganese ore is widely distributed in the Gold Coast, the mine at Dagwin being one of the largest in the world. This deposit lies along the Sekondi-Kumasi Railway, 35 miles from the port of Sekondi.⁴⁶ The ore occurs along a ridge about $2\frac{1}{2}$ miles long, and the entire hill is said to be rich enough to be put through the washing plant. The concentrate produced at the washing plant amounts to about 75 per cent of the entire volume of material treated and averages 49 to 55 per cent metallic manganese, 2 to 4 per cent iron, 3 to 7 per cent silica, and 0.1 to 0.12 per cent phosphorus. The ore is said to have been formed by the leaching of manganese from manganiferous phyllites and its redeposition along the cleavage planes and as nodules formed by concentration around nuclei in the red clayey soil. The mine is said to contain more than 10,000,000 tons of proved ore and a large tonnage of possible ore. At the present stage of development the mine can produce around 600,000 tons a year when Takaradi Harbor is completed. The port and plant were reported to have been completed near the end of 1928.⁴⁷ There are several other deposits in the Gold Coast that are as yet undeveloped.⁴⁸

The following table shows the manganese ore exported from the Gold Coast from 1924 to 1927.

Manganese ore exported from the Gold Coast, 1924-1927, in long tons ^a

Destination	1924	1925	1926	1927
Belgium.....	6, 014	-----	12, 902	27, 354
Canada.....	6, 565	50, 924	45, 774	61, 984
France.....	28, 859	42, 134	18, 213	62, 812
Germany.....	-----	6, 695	1, 953	-----
Netherlands.....	-----	1, 915	-----	-----
Norway.....	79, 538	142, 973	131, 746	144, 432
United Kingdom.....	44, 782	18, 646	30, 316	567
United States.....	67, 641	75, 370	104, 029	72, 056
	233, 402	338, 657	344, 933	369, 205

^a These figures represent dry weight of ore exported, as contrasted with the figures of natural weight shown in the world table on p. 236.

⁴⁶ Iron and Coal Trades Review, Jan. 6, 1928, p. 9.

⁴⁷ Engineering and Mining Journal, Jan. 19, 1929, p. 98.

⁴⁸ Mineral Resources of the United States, 1917 and 1925.

During the fiscal year ended March 31, 1928, the African Manganese Co., at Insuta, exported 334,535 long tons of manganese ore, valued at approximately 34s. per ton, compared with 398,551 tons, valued at about 36s. per ton, in the previous year. The decrease is attributed to the lower requirement by the steel industry in the United States during 1927.

MOROCCO

A new company, Compagnie Marocaine du Manganèse, was formed in Paris to exploit deposits of manganese ore in L'Oued Akrich and L'Oued Bou-Regreg.

The Bou Arfa deposit⁴⁹ occurs in the form of lens-shaped beds, some containing more than 100,000 tons. The total tonnage in sight is estimated at 3,000,000 to 4,000,000 tons, but much more development work is said to be required before an accurate summation of the potentialities of the deposit can be made. The ore is said to contain 50 per cent manganese, 5 per cent iron, 4 per cent silica, and 0.09 to 0.13 per cent phosphorus. Some high-grade pyrolusite is being mined and carried 75 miles by camels, carts, and lorries to the nearest railroad, and then hauled 225 miles by rail to the nearest port, thus indicating that transportation is one of the great obstacles to be overcome before the deposits can be exploited on a large scale.

NORTHERN RHODESIA

Samuel H. Day, American trade commissioner in Johannesburg, explains the situation at the Northern Rhodesia manganese deposits, as follows:⁵⁰

Referring to your letter of October 23 regarding the above, I am pleased to give you the following data which have been obtained from D. W. Jessup, an American who is the general manager of the Rhodesian Broken Hill Development Co. (Ltd.):

The 20 tons of manganese recorded in the Annual Report of the Rhodesian Chamber of Mines for 1927 refers to 20 long tons of manganese ore (mainly psilomelane) of an average value of 41.1 per cent Mn. This small consignment was sold to a customer in the Union Minière.

The 674 long tons of manganese ore used as a reagent in zinc works was of an approximate value of 50 per cent Mn.

The above ores were mined at two separate manganese deposits, viz: The Lubemba Manganese Claims and the Chowa Manganese Claims, situated, respectively, about 40 miles northeast and 10 miles east of Broken Hill. Both are owned and operated by the Rhodesia Broken Hill Development Co. (Ltd.).

The Lubemba deposit consists of a prominent outcrop, chiefly psilomelane, some 600 feet long and 100 feet wide, rising to a height of about 20 feet above ground level. Very little work has been done on this deposit, but taking into account exposures obtained in a few pits sunk to the north and southwest of the outcrop the available ore might be conservatively estimated at 50,000 long tons of an average value of 50 per cent MnO_2 .

The 20 long tons of manganese ore previously referred to were mined from this deposit.

The Chowa deposits occur in undifferentiated sedimentary schists close to a large granite area. The deposits are undoubtedly residual and consist of massive bedded psilomelane with a little manganite.

The overburden in the vicinity of the deposits consists of a manganese rubble and a laterite composed of pebbles of psilomelane cemented together by limonite, of a thickness varying from 3 to 12 feet.

⁴⁹ Beckett, F. M., African Manganese: Min. and Met. Soc. of America, Bull. 194, vol. 21, No. 2, March-April, 1928, pp. 25-35.

⁵⁰ Day, Samuel H., American trade commissioner, Johannesburg, South Africa, Manganese Production in Northern Rhodesia: No. 760, Feb. 6, 1929.

Mining operations have been confined to the massive bedded deposits, of which the known ores have now been mined out to the level of the country water table, approximately 20 feet below the ground surface. It is thought that these deposits will not extend to any great distance below the country water level.

Open pit mining, the ore being hand drilled, blasted, and carried to the surface, is the ordinary mining practice on these deposits.

From the information available the reserves are estimated at 3,000 long tons of manganese rubble averaging 50 per cent MnO_2 and a considerably larger amount of laterite averaging 30 to 40 per cent MnO_2 .

During the year 1928, 1,729 long tons of an average value of 53.3 per cent total Mn were mined from these deposits, the 674 tons originally referred to also being obtained from the Chowa manganese deposit.

The manganese ore is crushed in a Krupp mill to -60 mesh and is used as an oxidizing reagent in the electrolytic zinc plant owned and operated by this company.

TUNISIA

Tunisia produced 2,200 metric tons of manganese ore in 1928 (compared with 2,056 tons in 1927) and exported 760 tons.⁵¹

Several manganese deposits that appear to be especially promising prospects have been recently discovered in southern Tunisia.⁵² They are near Gafsa (35 miles from port of Sfax) and at Batoum. The ore is said to contain about 54 per cent manganese, 0.6 per cent iron, 2.6 per cent lime, and only traces of phosphorus and silica. It is claimed that material of such excellent analysis may be delivered regularly, and a British firm has undertaken development of the deposits. Plans call for a railway line to the sea; when completed this will make the deposit most accessible to European markets. The rail haul will be about 35 miles, and the freight rate from Tunisia to the European consumer will approximate 8s. The ore is now being hauled in trucks. The reserves are reported⁵³ to be about 400,000 long tons and to cover an area of 11,000 acres.

UNION OF SOUTH AFRICA

Much interest was shown in the new Postmasburg manganese field during 1928, but no production was reported. The manganese deposits are in Cape Colony, 125 miles west of Kimberley and a few miles north and west of the town of Postmasburg. The manganiferous area covers an unbroken line about 45 miles in length and up to 1,000 feet in width, striking nearly north-south. Although exposed in three places it is believed that only one bed exists, and that this has been duplicated by faulting. The ores are said to be physically and chemically suitable for the manufacture of chemicals, and the grade appears to be satisfactory for making ferromanganese. According to Doctor Hall:⁵⁴

The deposit indicates a ferrograde of ore. It contains from 42 to 58 per cent of metallic manganese, no phosphorus, from 1.75 to 7 per cent of silica and from 3.25 to 10.9 per cent of iron.

It is further stated that the reserves are large even though comparatively little development work at depth has been done. Doctor Hall, after a careful survey of a 6-mile stretch of the reef, roughly

⁵¹ Mining Journal (London), Mar. 3, 1929, p. 159.

⁵² Metallurgische Wirtschaft, Neue Zuführen aus Tunis: March, 1929, p. 242; see also Eng. and Min. Jour.

⁵³ Mining Journal (London), Feb. 16, 1929, p. 121.

⁵⁴ South African Mining and Engineering Journal, The Great Union Manganese Industry: June 9, 1928, pp. 415-419.

estimates 80,000,000 tons of ore within that limited area. Other engineers have estimated up to 500,000,000 tons for the entire field.

The Union Manganese Co. (Ltd.) is the largest holding company in the new field and is reported to own 153,000 acres, extending from Beeshoek, near Postmasburg, on the south to Bruce on the north. The company has concluded satisfactory arrangements with a British firm for the exploitation of its holdings.⁵⁵

German interests—Friedrich Krupp, A. G., and Gutehoffnungshütte-Oberhausen—are said to be negotiating with the Gloucester Manganese Co. for the right to work the company's property on the Gloucester farm and to produce around 100,000 tons yearly. The Germans have signified their willingness to pay a royalty of 2s. 6d. per ton. The final results of these negotiations have not been announced, but it is reported that an agreement satisfactory to both sides has been effected.⁵⁶ This agreement may ultimately have an important bearing on the success of the field, as the German interests represent steel companies with a reputed requirement of around 120,000 tons of manganese ore annually.

The Gamagara Manganese Corporation has large holdings in the field, and Belgian interests (Arthus-Greve Co.)⁵⁷ have been negotiating for an operating agreement. Certain American interests are said to have been examining parts of the field.

Practically all the negotiations carried on thus far in the Postmasburg district have been hindered by the transportation difficulties which may be removed as a result of the recent agreement between the British Swiss International Corporation and the Minister of Railways:⁵⁸

An important agreement was signed to-day between the Minister of Railways and the British Swiss International Corporation, (Ltd.), (a company registered in Great Britain), for the construction of a railway to serve the manganese deposits near Postmasburg, in the Cape Province. The company undertakes to furnish the capital, which will be returned at the end of 10 years, bearing interest at 4½ per cent. The railway will be State built, owned, and operated, but the company will make up any loss in working. During the first year the company will dispatch 200,000 tons of manganese ore by rail, and after that, for the remaining nine years, a minimum of 350,000 tons each year. Subject to satisfactory power and water arrangements, the company will erect works in the Union for the treatment of manganese ore up to 100,000 tons. The company is authorized, with the approval of the administration, to assign the contract to a company registered within the Union. The Union parliament will be asked to ratify this agreement as soon as possible.

The mode of occurrence of the Postmasburg deposits permits a cheap open-cut mining method. It is expected that owing to the hardness of the ore very little waste will result through fines. The nearest port, Port Elizabeth, is 483 miles distant by railway from the producing area. Doctor Hall estimates the cost per long ton c. i. f. United States or Great Britain as follows:

	£	s.	d.
Mining costs (surface mainly)-----		5	0
Railway to Port Elizabeth-----		10	1
Freight (bulk-ballast)-----	1	0	0
Handling charges-----		5	0
	2	0	1

⁵⁵ South African Mining and Engineering Journal, July 14, 1928, p. 567.

⁵⁶ Iron Age, Dec. 13, 1928, p. 1546.

⁵⁷ South African Mining and Engineering Journal, Feb. 23, 1929, p. 658.

⁵⁸ South African Mining Journal, State Aid (South African Manganese): Mar. 2, 1929, p. 157.

The value of the Postmasburg ore is not definitely known, but at 40 cents (1s. 8d.) per long ton unit for 45 per cent manganese ore a value of £3 15s. per long ton, c. i. f. Europe and United States Atlantic ports has been assumed. Another engineer states:⁵⁹

Mining offers no serious difficulties, and the total mining cost should not be more than 5s. per ton as an outside figure. The total cost, including realization, of placing the ore at European or Atlantic United States ports is estimated at 48s. 5d. per long ton for the next 10 years. This allows a fair margin of profit at the ruling price for manganese ore, which can be taken at 75s. per ton for a 50 per cent ore. It is estimated that the expenditure, including railways and sidings on the property but excluding the moneys required for building the railway to Postmasburg, would be in the neighborhood of £150,000. A profit of £1 per ton is estimated, after taking all factors into consideration.

It is believed that there are ample water-power resources on the Vaal River, 65 miles from the field, which might be used in the making of ferromanganese in the electric furnace. Natal is also interested in developing a local ferromanganese industry to utilize the Postmasburg ore and the surplus power generated at Colenso. The success of the venture depends upon closer railway facilities. The South African Iron & Steel Co. is importing its ferromanganese and ferrochrome. It is hoped that these commodities may be made from domestic chrome, iron, and manganese ores.

MANGANESE ORE IMPORTED INTO MAIN CONSUMING NATIONS

The following table shows the imports of manganese ore into the leading steel-manufacturing nations and the indicated source of the ore.

Manganese ore imported into the principal consuming countries, 1925-1928, by countries from which imported, in long tons^a

Importing country	Country from which imported	1925	1926	1927	1928	Source of information
Belgium-Luxemburg Economic Union.	Brazil.....	6, 103	2, 076	-----	37, 752	Official trade returns. ^b
	British India.....	134, 312	1 54, 031	94, 857	122, 977	
	Egypt.....	3, 037	26, 498	980	-----	
	Portuguese India.....	10, 197	4, 486	-----	-----	
	Russia.....	41, 221	65, 819	75, 183	62, 349	
	Other countries.....	2, 080	11, 484	94, 090	39, 819	
		196, 950	264, 394	265, 110	262, 897	
France.....	Brazil.....	14, 142	12, 482	22, 174	42, 489	Commerce Extérieur de la France. ^c
	British India.....	193, 199	239, 541	257, 077	262, 877	
	British West Africa.....	46, 780	37, 074	31, 984	77, 203	
	Russia.....	48, 539	90, 534	77, 508	108, 667	
	Spain.....	43, 377	47, 880	40, 546	13, 031	
	Other countries of Asia.....	42, 967	40, 531	34, 979	41, 793	
	Other countries.....	73, 143	132, 961	184, 904	180, 511	
		462, 147	601, 003	649, 172	726, 571	
Germany.....	Brazil.....	10, 463	5, 977	2, 529	27, 372	Official German trade statistics. ^b
	British India.....	68, 063	46, 536	75, 431	124, 594	
	British West Africa.....	15, 330	6, 511	(^d)	(^d)	
	Dutch East Indies.....	1, 726	4, 206	6, 133	12, 567	
	Egypt.....	12, 768	17, 054	46, 092	29, 489	
	Russia in Europe.....	6, 713	58, 420	(^d)	(^d)	
	Russia in Asia.....	55, 284	33, 058	207, 312	71, 060	
	Other countries.....	25, 879	24, 208	29, 567	14, 669	
		196, 226	195, 970	367, 064	279, 751	

^a Data compiled by Minerals Division, Bureau of Foreign and Domestic Commerce.

^b Figures for 1928 from Metal Bulletin.

^c Figures for 1928 from Iron and Coal Trade Review, Apr. 5, 1929, p. 500.

^d Included under "Other countries."

⁵⁹ South African Mining and Engineering Journal, June 9, 1928, p. 417.

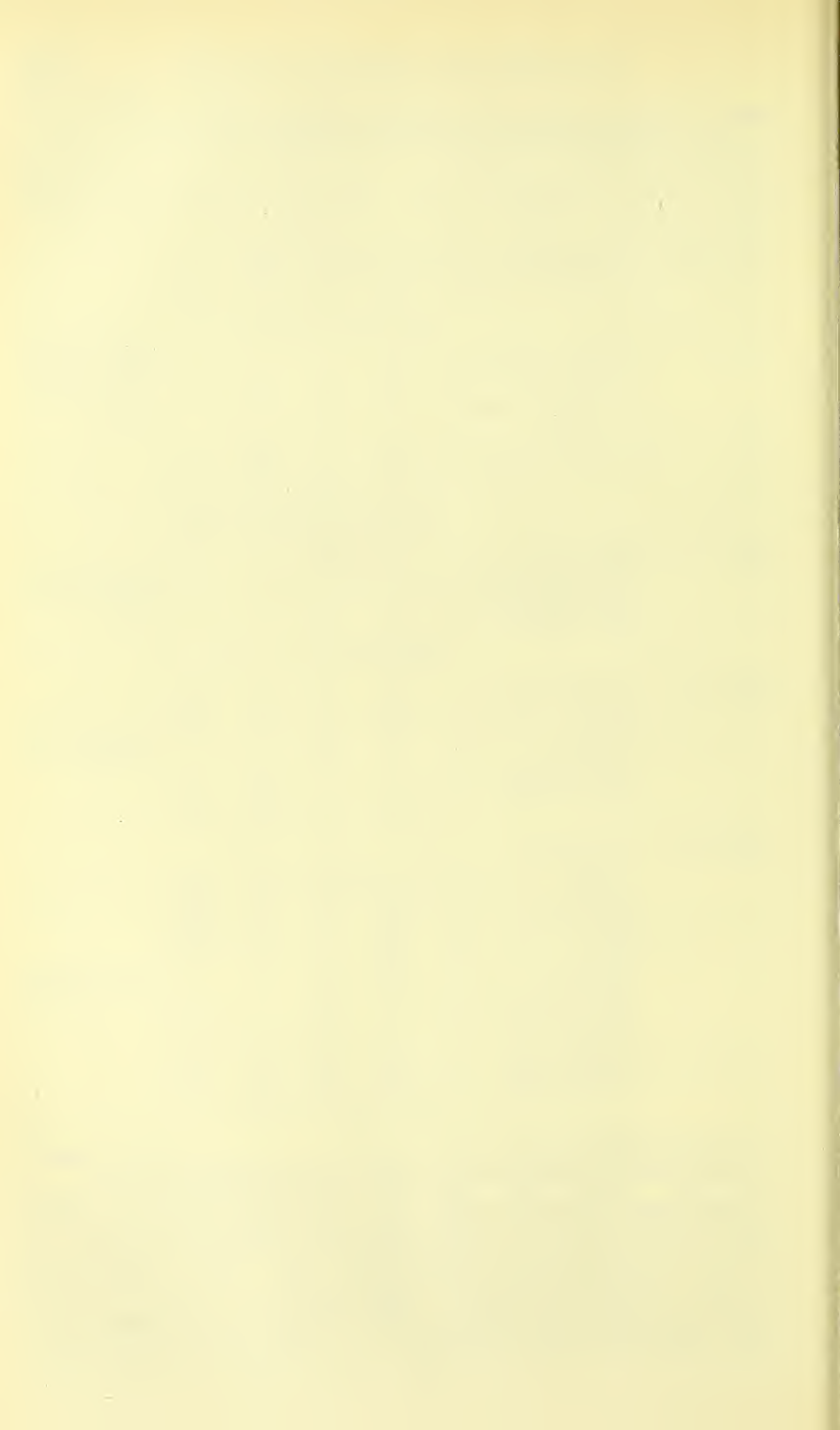
Manganese ore imported into the principal consuming countries, 1925-1928, by countries from which imported, in long tons—Continued

Importing country	Country from which imported	1925	1926	1927	1928	Source of information
Great Britain.....	British countries:					Annual Statement of the Trade of the United Kingdom with Foreign Countries and British Possessions.
	British India.....	170,096	81,710	176,757	(*)	
	Gold Coast.....	14,148	20,844	505	(*)	
	Other British countries.....	593	56	130	(*)	
		184,837	102,610	177,392	(*)	
	Foreign countries:					
	Brazil.....	11,908	-----	1	(*)	
	Japan and possessions.....	27	-----	-----	(*)	
	Java.....	-----	-----	1,973	(*)	
	Netherlands.....	442	96	197	(*)	
	Portuguese possessions in India.....	20,317	6,387	-----	(*)	
	Russia.....	55,985	32,101	13,061	(*)	
	Spain.....	2,051	-----	3,291	(*)	
	Other foreign countries.....	3,080	3,114	2,612	(*)	
Japan.....		93,810	41,698	21,135	(*)	Annual Report of the Empire of Japan.
		278,647	144,308	198,527	205,965	
	British India.....	-----	1,340	(*)	(*)	
	China.....	43,373	41,455	(*)	(*)	
	French Indo-China.....	-----	-----	(*)	(*)	
	Kwantung Province.....	2	-----	(*)	(*)	
	Straits Settlements.....	8,269	52,229	(*)	(*)	
	Other countries.....	1,151	43	(*)	(*)	
		52,795	95,067	(*)	(*)	
		-----	-----	-----	-----	
Netherlands.....	Belgium.....	139	58	-----	-----	Maandstatistiek van den in-uit-en Doorvoer.
	Dutch East Indies.....	1,714	1,361	1,212	1,895	
	Egypt.....	1,000	-----	-----	3,200	
	France.....	246	438	453	257	
	Germany.....	381	179	225	316	
	Italy (Fiume).....	24	386	-----	-----	
	Norway.....	5	140	-----	-----	
	Russia in Europe.....	-----	-----	3,961	300	
	Other countries.....	137	2	803	54	
		3,646	2,564	6,654	6,022	
United States.....	Africa (British):					Foreign Commerce and Navigation of the United States
	South.....	-----	12,946	-----	5	
	West.....	66,146	100,614	87,230	24,186	
	Brazil.....	228,438	272,287	174,026	142,300	
	British India.....	48,967	63,742	93,017	83,600	
	Canada.....	2,498	417	430	3,929	
	Chile.....	7,154	8,213	3,206	9,340	
	China.....	510	-----	-----	-----	
	Cuba.....	12,745	14,112	8,976	3,180	
	Germany.....	96	150	65	133	
	Hong Kong.....	1,296	-----	-----	-----	
	Italy.....	-----	6,083	-----	-----	
	Java and Madura.....	-----	594	1,527	1,026	
	Netherlands.....	10	25	-----	-----	
	Norway.....	-----	3,542	-----	-----	
	Russia in Europe.....	238,618	254,885	253,544	159,842	
	United Kingdom.....	3,275	206	46	167	
		7609,753	737,816	622,067	427,708	

* Figures not available.

† This figure differs from estimate shown on p. 203 and is due to difference between figures furnished by producers of Cuba and those furnished by the Bureau of Foreign and Domestic Commerce.

The French imported more ore in 1928 than any other nation, having received nearly 727,000 tons, compared with 649,000 tons in 1927. The imports into the United States were about 428,000 tons in 1928, compared with 622,000 tons in 1927. Great Britain made a slight increase and Belgium a slight decrease. Norway is said to have imported about 150,000 tons, through United States ports, presumably from the Gold Coast.



MERCURY

By PAUL M. TYLER¹

STATISTICAL SUMMARY

Summary of statistics for mercury in the United States, 1927-28

[Flasks of 75 pounds, except as indicated]

	1927	1928
Production.....flasks..	11, 276	18, 108
Number of producing mines.....	26	54
Average price per flask of 76 pounds:		
San Francisco.....	\$117. 61	\$125. 34
New York.....	\$118. 16	\$123. 51
London.....	£21 7s. 11d.	£22 6s. 1d.
Imports for consumption.....pounds..	1, 515, 535	1, 106, 726
Stocks in warehouse at end of the year.....equivalent in flasks..	20, 207	14, 756
	5, 736	5, 549

INTRODUCTION

During 1928 high prices, better metallurgical and mining technique, and expectations of increased consumption combined to stimulate in the United States the search for new mercury mines, the development of prospects, and the reworking of abandoned low-grade mines and old dumps. The increase in output from 11,276 flasks, valued at \$1,314,782, in 1927 to 18,108 flasks, valued at \$2,207,003, in 1928 falls far short of indicating the increased activity in mercury mining in this country. California, as usual, led the producing States and, with 17 additional producers in 1928, succeeded in increasing its 1927 output by almost one-fourth, producing 7,070 flasks. Oregon, hitherto an intermittent and usually insignificant factor, came forward in 1927 with an output of 2,082 flasks and in 1928 increased its output to 3,759 flasks. In Nevada developments took on the proportions of a boom. Substantial progress was also made in other States. The total number of mines reporting actual production increased from 17 in 1926 to 26 in 1927 and 54 in 1928. Even in 1928, however, three-fourths of the total output was furnished by only 8 producers, and there were 20 producers that reported less than 10 flasks each.

Most of the small mines treated fairly rich ore in retorts, but on an average nearly 9 tons of ore was treated for each flask of metal recovered. The yield, therefore, was approximately 8 pounds (0.40 per cent) of mercury per ton of ore charged in the furnaces. In a number of instances the recovery was only 4 or 5 pounds per ton, and one company was said to have obtained a profit from old dump material yielding as little as 1 pound per ton. In Nevada, on the

¹Unless otherwise stated, the statistics on the domestic industry in this report were prepared by H. M. Meyer, and the data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the Bureau of Mines.

other hand, a considerable body of ore that would yield as much as 3 per cent of mercury was said to have been developed.

The history of the mercury industry in the United States has indicated considerable flexibility both in supply and in demand under the influence of price. When the price of mercury became high production tended to increase and consumption to fall. For many years before 1915 the price of mercury in New York rarely exceeded \$50 and was generally below \$40 a flask. Recently it has been maintained at more than three times the latter figure, and the effect upon domestic production has been profound. In recent years about two-thirds of the American supply has been imported. Confidence in the future is freely expressed, provided tariff protection is not reduced, because the consummation of an agreement in 1928 covering the combined output of Italy and Spain, or more than 85 per cent of the world's supply, seems to assure some stabilization of prices—at least temporarily.

Curtailment in consumption, apart from the ups and downs of general business conditions involves substituting other cheaper materials for mercury. Approximately 1,000 uses are claimed for mercury, and in many lines the substitution has been virtually complete. In other lines there is a constant ebb and flow as consumers experiment with first one substitute and then another, only to return to mercury. To offset the loss of old outlets new uses are being found, and it is this condition apparently that accounts for the relatively high absorption of mercury by the American market in recent years in the face of comparatively high prices. H. W. Gould is credited with the statement that neon lights already consume about 1,000 flasks of mercury each year. Another authority mentions among new uses the making of soda to be employed in the manufacture of artificial silk, certain processes connected with petroleum refining, the manufacture of automatic switches for iceless refrigerators and other electrical devices, radio tubes, storage batteries, and a fertilizer compound for grass on golf courses.² The Emmet mercury boiler is another potential factor in future demands. Mercury heated in one boiler is used first like steam to drive a turbine and is thence exhausted into a second boiler which acts as a condenser for the mercury and as a source of steam to drive another turbine. In the General Electric Review (January, 1929) John Liston makes the following claim with respect to the equipment installed in the South Meadow Station at Hartford, Conn., and put into commercial service during October, 1928:

Preliminary results obtained to date indicate that the fuel economy of the process is rather better than the predicted results because of the high mercury-turbine efficiency. * * * The mercury-turbine, which is installed on the floor above the boiler, operates at full speed with entire absence of vibration, and the noise is so slight that it is difficult to detect by the sound when the turbine is running. The mercury condensers operate perfectly, a good vacuum being easily maintained at all loads.

Although there is no destructive consumption of mercury in a mercury power plant each new installation will absorb a considerable quantity of the metal, as between 6 and 8 pounds are required per boiler horsepower installed. It is proposed to use mercury as a heat carrier in a somewhat similar way for cracking gasoline.

² Eardley-Wilmot, V. L., The Occurrences, Metallurgy, and Uses of Quicksilver: Canadian Min. Jour., vol. 49, No. 52, Dec. 28, 1928, p. 1085.

In certain uses of mercury high prices do not constitute so important a factor in substitution as does the danger of mercury poisoning. Walter Roth³ writes of the danger from mercury as follows:

About two years ago Professor Stock called attention to the peril from quicksilver, which had been almost forgotten, and subsequent medical tests have justified him more and more. Professor Stock requests that the authorities give the mercury problem as much attention as the lead problem. In contrast to lead, mercury, on account of its volatility and its extensive use in amalgams, threatens not only individual trades but the widest circles. Copper amalgam is no longer used by dentists for fillings even in clinics. Professor Stock, however, demands that even the so-called noble-amalgam should no longer be used, since its composition varies too greatly and injuries from its use have been positively established. A metal alloy, free from quicksilver and other harmful substances, should be sought, which can be temporarily softened by a temperature bearable to the mouth to such an extent that it can be worked. Mercury in room, window, and bath thermometers, etc., should also be prohibited, since other liquids may be used. Physicians, chemists, physicists, etc., should also handle quicksilver equipment more cautiously, since individuals suffering from chronic mercury poisoning are especially sensitive to further exposure. No mercury should be permitted to stand uncovered. It should be heated only under exhausts. In handling it, dishes or other vessels should be set underneath carefully in order to avoid any spattered mercury. Cracks and fissures should not be tolerated in table tops, and, above all, ventilation of working rooms should be provided. Professor Stock has recently been investigating the mercury content of foods (flour and bread), which is caused by the increasingly extensive sterilization of seed grain.

To obtain comprehensive information on the amounts of mercury used by various industries, so that some estimate for future needs may be made available, an economic survey of the mercury industry has been conducted by the Pacific Experiment Station of the Bureau of Mines in cooperation with the University of California, Berkley, Calif. Consumers of mercury have cooperated generously with the Bureau of Mines in furnishing information concerning their requirements, so that it has been possible to account for more than 30,000 flasks used during the past year and to give the first reliable data concerning the channels of consumption of the metal in this country. The present market value of this material in the unrefined form would be between \$3,500,000 and \$4,000,000. Various individuals have estimated that the domestic consumption is from 32,000 to 35,000 flasks.

Pharmaceuticals, chemical manufacturing processes, neon and mercury lights, pigments and cosmetics, and the electrical industry are steady consumers. Mercury-containing disinfectants for seed treatment are gradually being replaced by cheaper substitutes.

Many attempts have been made to find substitutes for the mercury fulminate used in blasting caps and ammunition. Manufacturers have long threatened to use such substitutes at times of high mercury prices, but it seems significant that the use of the metal for explosive caps has not decreased during times of high prices. Bridge, dam, subway, mine, and all other work requiring explosives will be continued and will probably continue to take toll of mercury.

One surprising factor disclosed by the survey is the relatively large proportion of the mercury output used for scientific and technical instruments. The consumption of mercury for amalgamation processes of recovering gold, which is now declining and will soon be negligible, was formerly large, but the decline in this use has been more than compensated by the use of mercury for scientific and tech-

³Industrial and Engineering Chemistry, vol. 6, No. 17, Sept. 10, 1928, p. 5.

nical instruments. Modern industry has turned more and more to scientific and quasi-automatic-control methods in its processes. As mercury is a liquid metal at ordinary temperatures, it has in these processes a unique field of usefulness. To have faith in the future of modern industry is to have confidence in the future of mercury.

DOMESTIC PRODUCTION

The production of mercury in the United States increased from 11,276 flasks, valued at \$1,314,782, in 1927 to 18,108 flasks, valued at \$2,207,003, in 1928, or 61 per cent in quantity and 68 per cent in value. The number of mines contributing to the total output of mercury was 54 in 1928, compared with 26 in 1927. The mines producing in 1928 were distributed as follows: California, 26; Nevada, 17; Oregon, 4; Texas, 3; and Washington and Arizona, 2 each.

Mercury produced in the United States, 1919-1928

	Pro- duc- ing mines	Flasks of 75 pounds	Value		Pro- duc- ing mines	Flasks of 75 pounds	Value
1919.....	34	21,415	\$1,933,560	1927:			
1920.....	17	13,392	1,066,807	California.....	9	5,748	\$670,217
1921.....	11	6,339	300,595	Nevada.....	8	425	49,555
1922.....	10	6,375	368,348	Oregon.....	3	2,082	242,761
1923.....	14	7,937	521,302	Washington.....	1	566	65,996
1924.....	13	10,085	692,739	Texas, Alaska, and Arizona.....	5	2,455	286,253
1925:					26	11,276	1,314,782
California.....	7	7,614	632,936	1928:			
Texas, Nevada, Ari- zona, and Idaho.....	6	1,560	129,680	California.....	26	7,070	\$61,692
	13	9,174	762,616	Nevada.....	17	2,905	354,061
1926:				Oregon.....	4	3,759	458,147
California.....	7	5,726	526,237	Texas, Washington, and Arizona.....	7	4,374	533,103
Idaho.....	1	6	551		54	18,108	2,207,003
Nevada.....	4	197	18,105				
Washington.....	1	489	44,941				
Texas, Alaska, and Arizona.....	4	1,224	112,489				
	17	7,642	702,323				

MARKETS AND PRICES

In recent years the price of domestic mercury has been determined mainly by the European price. Even in 1928, despite the substantial increase in the output of American mines, almost one-half the apparent supply was imported. In previous years cooperative action by European producers has been a factor in sustaining prices, but the new agreement effected in 1928 attempts to stabilize the market by eliminating the frequent accumulations of stocks that formerly caused abnormal down swings from time to time. In 1928 the Spanish mines were closed a month longer than usual, and when they resumed work it was on a reduced scale.

According to a report from United States Consul Redecker,⁴ the provisions of the European agreement, which covers more than 85 per cent of the world output, are as follows:

Joint sales office.—The agreement provides for a joint sales office representing both Italian and Spanish producers to be established in a European country to be designated later by producers of the nationalities concerned.

⁴ Redecker, Sydney B., American consul, Naples, Italy, Consular Rept., July 19, 1928.

Distribution of production.—Under the agreement, Italy and Spain will produce quantities of mercury in proportion to the capacity of their respective mines, and the joint sales office will arrange for the disposition of the total production at uniform prices. The quantity of production allotted to Italy will be divided among the concerns "Amiata," "Siele," and "Idria," and other producing concerns of minor importance.

Disposition of existing stocks.—The first care of the common sales office will be to dispose of the large stocks of mercury accumulated in Italy and Spain during the last year of excessive production. In order to assist in reducing existing stocks to practicable proportions, both Italian and Spanish producers, for the present at least, will curtail their production.

Prices averaged substantially higher in 1928 than in 1927. The feature of the 1928 quotations is that the San Francisco prices were higher than those at New York, whereas in former years they have been consistently lower. In view of the fact that an increasing percentage of the domestic supply comes from American mines, a contrary tendency would be expected because much mercury is shipped from California to eastern markets to be sold, after freight is paid, in competition with imported metal.

Average yearly prices of mercury in the United States and the United Kingdom, 1915-1928

[Per flask of 75 pounds, except as indicated]

Year	San Francisco (domestic) ¹	New York ²	London ³	Year	San Francisco (domestic) ¹	New York ²	London ³
			£ s. d.				£ s. d.
1915.....	\$85.80	\$87.01	14 10 8	1922.....	\$57.78	\$58.95	11 11 6
1916.....	125.89	125.49	17 2 10	1923.....	65.68	66.50	10 4 9
1917.....	105.32	106.30	22 4 3	1924.....	68.69	69.76	11 19 8
1918.....	117.50	123.47	(⁴)	1925.....	82.67	83.13	13 17 1
1919.....	90.29	92.15	20 9 5½	1926.....	91.60	91.90	15 13 6
1920.....	79.66	81.12	20 14 9	1927.....	⁵ 117.61	⁵ 118.16	⁵ 21 7 11
1921.....	47.42	45.46	11 3 5	1928.....	⁵ 125.34	⁵ 123.51	⁵ 22 6 1

¹ Mining and Scientific Press, San Francisco. } Eng. and Min. Jour.-Press, 1922-1925; Eng. and Min.
² Engineering and Mining Journal, New York. } Jour., 1926-1928.

³ Mining Journal (London).

⁴ Quoted as "nominal" only.

⁵ Price quoted on 76-pound flask for 1927 and 1928.

Prices of domestic mercury at San Francisco, 1924-1928, by months¹

[Per flask of 75 pounds, except as indicated]

Month	1924	1925	1926	1927 ²	1928 ²	Month	1924	1925	1926	1927 ²	1928 ²
January.....	\$59.56	\$81.16	\$90.13	\$99.66	\$128.29	July.....	\$71.70	\$82.71	\$90.10	\$119.47	\$124.00
February.....	59.53	80.90	89.00	100.92	126.00	August.....	71.47	82.50	89.42	121.50	123.83
March.....	61.27	80.85	89.01	105.00	122.47	September..	71.54	81.28	89.83	120.84	128.00
April.....	71.33	81.34	89.25	117.87	121.83	October.....	71.64	81.10	94.27	124.27	130.50
May.....	72.65	81.60	90.60	124.75	122.83	November....	72.43	88.04	98.33	128.79	126.67
June.....	71.91	82.21	90.71	118.92	124.50	December....	70.84	90.39	98.84	129.37	125.13

¹ Engineering and Mining Journal.

² Price quoted on 76-pound flask after June, 1927.

In harmony with the increased price of the metal the prices of mercurial chemicals were higher in 1928 than in 1927. At the end of 1928 calomel was quoted by the Oil, Paint, and Drug Reporter at \$2.05 a pound, bisulphate at \$1.63, red precipitate at \$2.16, white precipitate at \$2.24, and blue mass at \$1.02. Prices of vermilion red (English mercury) exhibited considerable fluctuation, in conformity with the changes in the mercury market; the high quotation for 1928, \$2 a pound, was 5 cents higher than the high figure for 1927,

and the low figure of \$1.75 was 20 cents higher than the 1927 low quotation.

The following comments upon the future course of metal prices are credited to Dr. Alfred Marcus,⁵ of Berlin, Germany.

Those industries which need relatively larger quantities of quicksilver and which have to meet a more serious competition from other industries, as, for instance, the important industry of quicksilver colors in Germany, are troubled by the price development of this metal during the last years. The following figures of the average prices in London show the growth of prices in recent years:

	£	s.	d.		£	s.	d.
1913-----	7	10	0	1924-----	11	12	6
1921-----	20	3	5	1925-----	13	15	0
1922-----	11	11	6	1926-----	15	9	6
1923-----	10	4	9	1927-----	21	5	0

The average price for the first six months of the current year exceeds £22. This price development became possible by the fact that a cartel has been formed by the Italian and Spanish quicksilver producers, which represent the bulk of the world's production. Though the quicksilver output of the Italian and Spanish mines has hitherto considerably increased, their common selling policy has prevented competitive offers and the accumulation of stocks in consuming countries, though stocks in mines have increased essentially. Now a restriction of output is intended in order to prevent a further increase of quicksilver stocks stored up in mines. Considering this situation, it is to be asked whether those countries which are exclusively consumers, that is to say, the whole of Europe, other than Italy and Spain, can not find any expedient to avoid the price dictation of the quicksilver cartel, which makes possible so excessively high profits. The production costs of Almadén amount to-day to about £14 a flask, so that between production costs and selling prices there is now a margin of £8, or about 55 per cent. It is evident that any consuming circles that wish to break the monopoly must favor the development of mines not belonging to the cartel. All attempts made hitherto in this way (for example, reopening of the Mexican mines) have been unsuccessful. Some chances may exist in the north of Africa, where the mines of Ras-El-Ma are going to be developed. But it is not impossible that these mines will also enter into the cartel. Nor can it be said that the projects pursued by the British I. C. I. Trust in New Zealand will get more important results for consumers.

CONSUMPTION AND SUPPLY

Supply of mercury in the United States, 1908-1928

Year	Production		Imports for consumption		Exports		Apparent supply	
	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value
1908-----	19,752	\$872,446	202	\$8,216	2,996	\$124,960	16,958	\$755,702
1909-----	21,075	957,559	213	8,203	6,802	266,243	14,486	699,819
1910-----	20,601	958,153	9	381	1,923	91,077	18,687	867,457
1911-----	21,256	977,989	6,292	251,386	291	13,995	27,257	1,215,380
1912-----	25,064	1,053,941	1,103	39,920	310	13,360	25,857	1,080,501
1913-----	20,213	813,171	2,289	75,361	1,140	43,574	21,362	844,958
1914-----	16,548	811,680	8,198	271,984	1,446	70,753	23,300	1,012,911
1915-----	21,033	1,804,631	5,625	282,752	3,372	225,509	23,286	1,861,874
1916-----	29,932	3,768,139	5,659	515,919	8,880	670,475	26,711	3,613,583
1917-----	36,159	3,808,266	5,207	448,032	10,778	998,470	30,588	3,257,828
1918-----	32,883	3,863,752	6,719	533,622	3,098	338,620	36,504	4,058,754
1919-----	21,415	1,933,560	10,635	791,226	9,107	817,328	22,943	1,907,458
1920-----	13,392	1,066,807	14,169	971,510	1,553	129,993	26,008	1,908,324
1921-----	6,339	300,595	10,601	457,993	393	18,869	16,547	739,719
1922-----	6,375	368,348	16,920	757,842	291	15,910	23,004	1,110,280
1923-----	7,937	521,302	18,073	816,043	318	25,195	25,692	1,312,150
1924-----	10,085	692,739	13,170	566,820	208	14,333	23,047	1,245,226
1925-----	9,174	762,616	20,855	1,200,878	204	15,930	29,825	1,947,564
1926-----	7,642	702,323	25,976	1,784,250	116	10,319	33,502	2,476,254
1927-----	11,276	1,314,782	20,207	1,780,134	(a)	(a)	^b 31,300	^b 3,077,000
1928-----	18,108	2,207,003	14,756	1,437,153	(a)	(a)	^b 32,700	^b 3,626,000

^a Not separately classified for 1927 and 1928.

^b Estimated by Bureau of Mines.

⁵ Mining Journal (London), Quicksilver Cartel and its Price Policy: Vol. 162, July 14, 1928, p. 602.

IMPORTS AND EXPORTS

The general imports of mercury decreased 37 per cent, from 24,650 flasks in 1927 to 15,583 flasks in 1928. The imports in 1927 were, in turn, considerably less than those in 1926, the peak year, when they amounted to 28,614 flasks. In 1928, for the first time since 1919, the imports were lower than the domestic production. The imports in 1928 came from Spain, 6,189 flasks; Italy, 5,718 flasks; Mexico, 1,816 flasks; Belgium, 913 flasks; Germany, 546 flasks; and the United Kingdom, 401 flasks. Stocks in bonded warehouse were 5,549 flasks at the end of 1928, compared with 5,736 flasks at the end of 1927.

Mercury imported for consumption in the United States, 1919-1928

Year	Pounds	Metric tons	Flasks	Value
1919.....	797,613	361.79	10,635	\$791,226
1920.....	1,062,647	482.01	14,169	971,510
1921.....	795,078	360.64	10,601	457,993
1922.....	1,269,004	575.61	16,920	757,842
1923.....	1,355,499	614.84	18,073	816,043
1924.....	987,719	448.02	13,170	566,820
1925.....	1,564,112	709.47	20,855	1,200,878
1926.....	1,948,170	883.68	25,976	1,784,250
1927.....	1,515,535	687.44	20,207	1,780,134
1928.....	1,106,736	502.01	14,756	1,437,153

Mercury imported into the United States, 1925-1928, by countries

[General imports]

Country	1925		1926		1927		1928	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Belgium.....	11,250	\$9,700					68,454	\$93,823
Canada.....	22,500	18,828	13,310	\$11,678			5	10
Chile.....					300	\$490		
Germany.....	6	7	1,670	1,501			40,954	57,414
Hong Kong.....					5	6		
Italy.....	843,358	640,150	832,589	830,781	681,653	791,060	423,821	558,622
Mexico.....	74,377	50,607	80,412	67,609	138,268	161,490	136,208	176,968
Netherlands.....					3,800	4,458		
Portugal.....			59,220	47,466				
Spain.....	731,569	579,344	1,058,775	966,368	1,024,742	1,231,991	464,206	643,621
Turkey in Europe.....			12,600	11,178				
United Kingdom.....	25,500	22,950	37,500	34,877			30,100	41,559
	1,708,560	1,321,586	2,146,076	1,971,458	1,848,768	2,189,495	1,168,748	1,572,017

Mercury exported from the United States, 1919-1928

Year	Pounds	Metric tons	Flasks	Value
1919.....	683,004	309.80	9,107	\$817,328
1920.....	116,493	52.84	1,553	129,093
1921.....	29,501	13.38	393	18,869
1922.....	21,834	9.90	291	15,910
1923.....	23,827	10.81	318	25,195
1924.....	15,581	7.07	208	14,333
1925.....	15,289	6.93	204	15,930
1926.....	8,668	3.93	116	10,319
1927-28.....	(1)	(1)	(1)	(1)

¹ Not separately classified for 1927 and 1928.

Vermilion reds (containing quicksilver), dry or ground in oil or water, imported for consumption in the United States, 1921-1928

Year	Pounds	Value	Duty
1921.....	4,756	\$4,138	\$620.70
1922:			
Jan.-Sept. 21.....	377	276	41.40
Sept. 22-Dec. 31.....	12,991	9,757	3,637.48
1923.....	78,449	61,104	21,965.72
1924.....	96,410	74,693	26,994.80
1925.....	173,334	154,479	48,533.52
1926.....	176,020	169,266	49,285.60
1927.....	108,076	127,806	30,261.28
1928.....	96,248	127,752	26,949.44

MINING INDUSTRY BY STATES

ALASKA

Deposits of mercury (associated with serpentine, together with antimony and copper) have been located at the head of Slippery Creek, a tributary of McKinley River, in the Mount McKinley and Kantishna districts (Kuskokwim region) of Alaska; very little mercury has been produced, although small quantities recovered in prospecting appear to have been sold from time to time to local placer miners.

ARIZONA

The United Verde Extension Mining Co. in December secured an option on a majority of the stock of the Quicksilver Corporation of America, owning properties in Dreamy Draw, a few miles northeast of Phoenix. A 150-foot shaft has been sunk and a Diesel power plant and a 200-foot compressor have been installed. In the lower 20 feet of the shaft the finding of ore averaging 60 pounds of mercury to the ton was reported.

The Arizona Cinnabar Co., the Tonto Co., and the Mines Mercury Co. have been consolidated, and the new company will erect a treatment plant, with a daily capacity of 200 tons, at a central point. A good road built recently to connect with the main road through Tonto Basin to Payson has made these properties accessible.

CALIFORNIA

In 1928 California supplied 39 per cent of the total domestic production of mercury. The principal producing mines were the Sulphur Bank in Lake County, Knoxville in Napa County, New Idria in San Benito County, Oceanic in San Luis Obispo County, and Cloverdale in Sonoma County. Descriptions of these mines were given by J. W. Furness in the chapter of this series for 1927. At the famous New Almaden mine the only output was by lessees working the dumps.

At the Sulphur Bank mine in Lake County the F. W. Bradley interests of San Francisco have erected a 500-ton mill which should provide concentrates sufficient for the present furnace capacity. Because of the high moisture content furnacing the raw ore involved great difficulties. H. P. Davy has leased the Mirabel mercury property 4 miles south of Middletown, Lake County. This property, abandoned in 1897, was reopened in 1908 and again in 1916, but has since been idle. A vertical shaft has been sunk to a depth of 500 feet.

In November it was reported that the Altoona mercury mine was to be reopened. Prior to being closed a few years ago it had produced nearly 30,000 flasks.

The Butte Development Co. (of Nevada) has acquired the Culver-Baer mercury property lying east of Cloverdale. This old property, long idle, is now equipped with a compressor and with coarse and fine ore furnaces. A new rotary furnace will be installed. Roads to the mine have been improved recently.

H. F. McClellan purchased the Garretson Spring cinnabar mine in Siskiyou County from Mrs. A. M. Cogswill. In December, 1928, it was reported that 2 tons of 3 per cent ore was being retorted daily at this mine. According to a newspaper report, a 6-tube retort having a capacity of 50 tons a day was to be installed, and 15 men would be needed. At the Great Northern mine, also in Siskiyou County, 26 miles northwest of Yreka, a leaching process for the recovery of mercury was being worked out and a 50-ton plant was installed. It is claimed that this process would result in lower costs and would remove the danger of salivating employees. The mine is now known as the J. M. P. and is owned by Lewis Aubury, W. W. Young, and George James.

About the middle of the year the Acme Mining & Milling Co. was formed to develop the La Joya mercury property in Napa County, 6 miles west of St. Helena. W. E. Moser is president of the new company, H. W. Gould is vice president, B. C. Austin is secretary-treasurer, and Edward E. Leister is superintendent. The property consists of 10 patented claims and 480 acres of farm land. The new plant consists of a 3 by 40 foot Gould improved rotary furnace and condensing system. The machinery is electrically driven by power generated at the mine and is as nearly automatic as is practicable for a large plant of this nature. It requires only four men for 24 hours. The 40-ton capacity furnace, said to be capable of turning out about 150 flasks of mercury monthly, began operating in November, 1928. Early in 1929 Superintendent Leister reported that the mine was producing approximately up to furnace capacity and that development work was satisfactory. In November, 1928, the reserves above the 300-foot level were estimated at 40,000 tons. In 1929 the Acme Mining & Milling Co. installed a Gould furnace (100 tons daily capacity) and a retort at the Oat Hill mine in Napa County.

The Tonopah North Star Tunnel & Development Co. and the Myra Mining Co. have reopened the Reed mercury mine near Knoxville, Yolo County. The main tunnel has been cleared out for 15 feet, and rails have been laid from the dump to and into the adit. Supplies and material for the development of the mine have been hauled in, and camp buildings have been completed.

IDAHO

Further prospecting and development work were carried on in the Yellow Pine district of Valley County. This district has been described by Schrader and Ross.⁶ Hansen and Wills, working pan-amalgamation tailings at De Lamar Millsite, Owyhee County, were the only operators reporting production of mercury in Idaho in 1928.

⁶ Schrader, F. C., and Ross, C. P., Antimony and Quicksilver Deposits in the Yellow Pine District, Idaho: U. S. Geol. Survey Bull. 780, 1926, pp. 137-161.

Their output was 16 flasks. Mercury recovered in this way is considered secondary mercury and is not included in the figures of output for 1928 as it has entered into the statistics of production for some earlier year.

NEVADA

As was forecast by Furness in the chapter of this series for 1927, both the Nevada Quicksilver Mines (Inc.) and the Pershing Quicksilver Co. in Pershing County were active producers in 1928. The B and B Quicksilver Co. and Good & McKinney in Esmeralda County both produced considerable metal.

The Antelope Springs district in Pershing County covers a mineralized area of 12 square miles, half of which is owned by the Central Pacific Railroad Co. under United States patents; it includes the properties of the Nevada Quicksilver Mines (Inc.) and the Pershing Quicksilver Co. and numerous individual claims that are constantly changing hands. Although the boom in mercury mining in 1928 has centered attention upon the Friedman property (the Nevada Quicksilver Mines (Inc.)), the presence of mercury in Pershing County has been known for 15 years. In 1914 Mr. Dolbear erected a 12-tube retort on ground now owned by the Pershing company. Later a California woman erected a similar retort $1\frac{1}{2}$ miles to the east. Mining, however, was confined to shallow diggings and both ventures failed. Two years ago W. G. Adamson (Pershing Quicksilver Co.) acquired the Dolbear property and in 15 months blocked above the 200-foot level 70,000 tons of 10-pound ore; the pay shoots ranged from 5 to 40 feet in width.

The property of the Nevada Quicksilver Mines (Inc.), popularly known as the Friedman property, covers 328 acres in the Relief district at Antelope, 21 miles east of Lovelock. The original purchase (the Juniper mercury mine, $1\frac{1}{2}$ miles east of the Adamson holdings) was made by Louis A. Friedman from John Benedict. The company now possesses 6 unpatented mining claims, 1 unpatented placer claim, and 160 acres of unpatented railroad-grant land. The Nevada Quicksilver company's mine was in 1928 the largest producer of mercury in Nevada and one of the largest in the United States. Between 30 and 40 tons of ore may be treated daily. Nine months after the property was acquired by the present company as an unproved prospect it was developed to a depth of 250 feet, and by November 30, 1928, a 2-compartment incline shaft was down 320 feet, where high-grade ore similar to the rich surface ore was found. From the new headframe of the shaft ore is delivered direct to the furnace bins, being trammed not more than 75 or 100 feet from the stopes. The following description of the mine development and the plant is given by H. W. Gould:⁷

In width the ore body ranges from 5 to 15 feet. The ground stands fairly well and little timber is required. Just what method of mining will eventually be used has not been definitely determined, but my opinion is that the shrinkage system can be used in short lifts. In soft ground it may be necessary to break and fill.

As drawn from the stope chutes the ore is trammed to the shaft pockets and hoisted to the surface in a $1\frac{1}{2}$ -ton skip. The headframe gives ample bin space. The ore is dumped on a 4 by 12 foot grizzly with openings from 2 to $2\frac{1}{2}$ inches. Oversize is crushed in a Blake-type jaw crusher set to discharge a 2 to $2\frac{1}{2}$ inch

⁷ Engineering and Mining Journal, Nevada Quicksilver Mines (Inc.) Operates New Plant: Vol. 127, Jan. 5, 1929, pp. 7-9.

product that joins the grizzly undersize in the fine-ore bin. Live storage in the coarse-ore bins is about 40 tons, and live storage in the fine-ore bins is about 50 tons. The headframe is arranged so that more storage can be constructed, as the plant has been designed to accommodate a second furnace.

The mine plant is in a building 30 by 45 feet, divided into a hoist room 30 by 30 feet and a blacksmith shop 30 by 15 feet. Equipment consists of 750-cubic foot Ingersoll-Rand compressor driven by a 150-horsepower motor-driven hoist. The building is of wood frame, covered with corrugated steel on the outside and lined with sheeting on the inside. The blacksmith shop is completely equipped with power drill, Sullivan drill sharpener, and tools. Ample air for all needs is supplied by the compressor. Power is supplied by the Nevada Valleys Power Co. over a newly constructed power line. The mine makes sufficient water for all purposes.

The reduction plant contains a Gould rotary furnace equipped with dust precipitators and condensing system with a capacity of 40 tons daily. This furnace is 3 feet in diameter by 40 feet in length, revolving once in 40 to 42 seconds. Ore feeds by gravity direct from the headframe ore bin to a shaker feeder which passes it into the furnace. A new type of lifting vane carries it away from the head end of the furnace immediately. The ore, mixed feed up to 2½-inch size, carries a considerable amount of fines. It requires about 30 minutes for it to pass through the furnace to the point where it drops into a 40-ton steel calcine bin, from which it is trammed to the calcine dump. Oil of a gravity of 24° to 27° B. is used for fuel, and costs about 6½ cents delivered to two 10,000-gallon tanks placed at a level above the hoisting house, from which point it flows by gravity to the plant. Air from a small 6 by 6 inch horizontal Sullivan compressor is used for atomizing. Oil and air pressures are the same and range from 40 to 60 pounds. The furnace, compressor, blower, feeder, and a high-pressure water pump are driven by individual motors.

Firing hood and furnace header are of steel construction lined with fire brick. Gases are taken from the header by a No. 9 exhaustor of Monel metal. It is belt driven by a 5-horsepower motor and has a capacity of about 2,000 cubic feet per minute. The speed is constant, but a damper placed between the exhaustor and the header regulates the draft closely. Gases from the exhaustor pass through a 38-inch cyclone dust precipitator and thence into a larger one 48 inches (inside diameter). These precipitators are of a new type and have been developed especially for this work. They are efficient and, with the dust header, collect close to 99 per cent of the dust in the gas stream as it leaves the furnace. Each precipitator is made with double shell with 5-inch space between, which is filled with Silocel for heat insulation and prevents premature precipitation of the quicksilver.

Gases leaving the second dust precipitator pass down through an alloy metal pipe 18 inches in diameter to the condensing system. In this pipe are placed two high-pressure water sprays (about 150 pounds pressure), which serve to knock down any remaining fine dust from the gas stream.

The condensing system contains seven units, each unit consisting of two 18-inch vertical pipes 20 feet long with U connections at the top. Each unit has a hopper bottom with a 6-inch vertical outlet pipe. Each outlet pipe sets in an iron bucket, and from 2 to 3 inches of water is used to effect a seal. To clean up the condensing system it is only necessary to change the buckets once a day. The condensing system is made of nickel-copper alloy, pipes being of 24-gage and hoppers of 16-gage metal. From the end of the metal condensing system an 18-inch alloy metal pipe carries the gases to a series of three connected redwood settling chambers and thence by an 18-inch vitrified tile pipe line to a 60-foot stack. The chambers are 10 feet in diameter by 20 feet high and have cone bottoms. The outlet is a water-sealed 12-inch vitrified tile pipe.

Wide redwood launders carry all water from the condensing system and settling tanks to a central concrete tank. The overflow of this is carried to two redwood settling tanks, 12 feet in diameter and 3 feet deep. Water leaving the tanks is clear and shows no trace of quicksilver. The reduction equipment, with the exception of the redwood settling tanks and a stack, is housed in a 35 by 56 foot steel-frame building painted inside and out. Concrete floors are provided. An additional furnace unit can be accommodated when required.

Lloyd Lathrap, superintendent, furnished the following information about operations: The furnace header collects from 250 to 350 pounds of dust daily. This dust assays about the same as the mine run of ore, quicksilver content being in the form of cinnabar rather than as the metal. The dust is dropped from the header by a bottom gate to a concrete box and is sluiced to the settling tanks

outside of the plant. The first precipitator collects from 200 to 300 pounds of dust daily which assays from 3 to 9 pounds of mercury per ton, the valuable constituent being the fine cinnabar, again. This dust drops from the cyclone to a small concrete box and is blown out twice a day through a 4-inch pipe to a storage pile on the hillside.

The second precipitator collects about 400 pounds of dust weekly which assays 20 to 100 pounds mercury per ton. Dust is cleaned out weekly and sluiced to the same settling tank to which the dust from the header is sent. Later all this dust will be put back through the furnace.

A TAG recording thermometer is installed at the top of the second dust precipitator in the downcast pipe to the condensing system and shows an average daily temperature of 415° F. The card shows a daily range of from 390° to 440° F. Below this thermometer are two water sprays which are the only sprays in the system and operate at about 150 pounds pressure. Water is furnished to the sprays by a small high-pressure pump, motor driven.

No. 1 hopper of the condensing system delivers a high-grade product containing a little dust. No. 2 hopper delivers the cleanest product and over 50 per cent of the quicksilver is obtained at this point. No. 3 hopper usually delivers a high-grade product also. The product from the three hoppers is better than 95 per cent of the quicksilver output of the plant and is always treated with lime on the soot table, and reject from the table being sent directly back to the furnace feeder.

No. 4 hopper yields a product which can be treated on the soot table, but usually it is so badly fouled with antimony that it can not be worked and is therefore sent back into the furnace. The product from No. 5 hopper is for the most part antimony, as the ore from this mine carries some stibnite. This product, as well as that from hoppers 6, 7, and 8, which yield only a low-grade soot, is dried and returned to the furnace feeder. The cleanup can be made at any time, or continuously, and is accomplished by simply changing the buckets under the various hoppers when necessary. Cleanup material, either in part or entirely, is dumped on a soot wagon made especially for the purpose. This wagon is 4 feet wide, 6 feet long, and slopes $\frac{1}{4}$ inch per foot to one corner; sides are 6 inches high and slope inward. The low corner is drilled and fitted with a gooseneck to insure clean mercury. It is mounted on a truck with Universal 12-inch rubber-tired wheels. The cleanup can be wheeled to any desired location to lime and hoe, or it can be pushed under the furnace to dry. Residue, which consists of a few buckets of soot, is fed back into the furnace.

A small amount of quicksilver and a little soot settle in the redwood tanks, making a low-grade soot or mud. So little shows in the tanks to date that no plan has been adopted for working it, but it will probably be dried and returned to the furnace with the dust from the cyclone precipitators.

Calcene discharged from the furnace is bright red in color. Calcene assays never show more than a trace of quicksilver. Gold foil placed at the top of the stack shows no signs of quicksilver at the end of two hours, only a few small spots after six hours, and no appreciable amount at the end of 24 hours. As mentioned before, the temperature of the gases leaving the dust precipitator averages about 415° F. The stack temperature averaged 107° F. with atmospheric temperature at 84° F. These temperatures were taken in the afternoon.

Oil consumption averages about 7 gallons per ton of ore treated. This varies considerably, depending on the moisture content of the ore. The plant treats from 30 to 40 tons daily, depending on the amount of fines in the ore. The average since starting is about 33 tons per 24 hours. Production so far has averaged a little better than 20 flasks per day, or approximately 600 flasks per month.

To Gould also is credited the following description of the character of the Friedman deposits:⁸

The geology of the district, as indicated at the Friedman mine and at the Adamson mine, 3 miles southeast, is in some respects similar to, but in others unlike, that of any other quicksilver mining district in this country, to my knowledge. The rocks are almost entirely sedimentary, consisting of limestone, lime shales, and shales. A few remnants of a basic volcanic flow are shown in the form of a capping on the higher hills, but apparently that flow is not related to the ore deposition. A short distance west of the Adamson property, I am told, an intrusive dike parallels the mineralized zone in that mine. The dike may

⁸Work cited, pp. 6-7.

extend on the west of the Friedman property, and possibly it is in some way related to the ore deposition. The shale and limestone beds are for the most part highly contorted both by folding and faulting. A striking exception to this disturbance is a limestone bed about 50 feet thick which follows a regular course through two claims for about 3,000 feet and for about an equal distance in adjoining properties northwest and southeast. The limestone bed strikes north 30° west and generally dips east at about 45°, but the dip grows steeper to the north and on the adjoining property it is almost vertical. This limestone underlies a bed of thinly laminated fine-textured shale, and although it is not greatly disturbed by folding along the strike, there are many faults, mostly of small displacement; however, two are present with throws up to 50 feet or more. The mine is located in this limestone, and the ore occurs in the fractures at or near the contact with the overlying shale. The fractures are at various angles to the contact, from approximately parallel to almost right angles, and though the mineralization may extend as much as 50 feet away from the contact, as it does in the main cross fracture showing on the 100 level, mineralization invariably increases as the contact is approached, with the larger bodies of high-grade ore always in the near vicinity of the overlying shale, which formed a barrier to the free passage of the mineral-bearing solutions and caused precipitation of the cinnabar at this point. This is a common feature of quicksilver deposits, the ore occurring in an open-textured area under a tight hanging wall.

The overlying shale is called the hanging wall; however, not in the ordinary sense of a hanging wall to an individual vein, but as a hanging wall of the ore zone in its entirety, the ore occurring in numerous fractures which may cut the hanging wall, but which carry ore only under it or in the immediate vicinity. Though the limestone bed is, in general, quite dense and hard, it has in places been extensively fractured, leaving an open-textured structure, and here the mineral-bearing solutions have entered.

At this property the productive mine workings are mainly in the fractured area, and there are at least three other similar areas on the property, two of them on the north and one to the south of the present workings. About 600 feet east of the mine workings there is another pronounced fissure system in a limestone formation paralleling the one heretofore mentioned. Along this fissure, for 500 feet, pinnings of the surface rock show considerable cinnabar, and a crosscut tunnel is now being driven under this area which shows possibilities of making another ore shoot. Several other good prospects have been found on the property, but so far they have not been developed.

The surface labor consists of 1 plant foreman, 3 furnace men, 1 man to clean and bottle the mercury, and 1 man to run a rock crusher; mine labor consists of 1 mine foreman, 2 hoist engineers, and 2 car men. There are 3 miners and 2 shovelers employed in the stopes, 4 miners in development work and in sinking the mine shaft, and 3 miners and 3 shovelers on outside prospecting and on other parts of the property. Miscellaneous labor consists of 4 men. The mine thus employs 30 men altogether.

The Pershing Quicksilver Co., whose property is about 25 miles from Lovelock, has the largest mercury mine in Nevada, but production in 1928 was less than that of the Nevada Quicksilver company's mine. The first furnace of the Pershing company went into operation the latter part of 1927. Upon the completion of a second furnace, which was to be in place by November, 1928, it was expected that production would be trebled. The first shipment, that made in March, 1928, was a 100-flask lot and brought \$120 to \$125 a flask. The ore of the Pershing mine is "more of a disseminated deposit, of lower grade, but covering a wide area." The ore zone, in which lime and shale beds alternate, has been crosscut for a width of 400 feet and opened by drifts for a length of 500 feet, with surface mineralization extending the length of at least 400 feet.

The Cinnabar King Mining Co. took over the mine in Spring Valley Gulch, 1 mile north of Rochester, formerly held by W. H. Harris. The property comprises 160 acres, midway between Spring Valley

and American Canyon. George S. Clack, who is the manager, declares that there is strong evidence to support the theory that the mercury deposits in the Antelope Springs district—the Nevada Quicksilver Mines (Inc.) and the Pershing Quicksilver Co.—persist through the mountain range that separates the Antelope Springs holdings from the Cinnabar King Mining Co.'s mine. The ore of this mine runs high in mercury, and mineralization has been traced by panning for more than a mile. Four 1½-ton retorts have been installed, looking toward a daily treatment of about 3 tons of ore (2 flasks of metal a day).

Since the B & B Quicksilver Co. in 1927 purchased the mercury property in the Fish Lake Valley district west of Tonopah, on the northeast slope of Mount Montgomery in the White Mountain Range in western Esmeralda County, it has made great improvement in equipment and in means of transportation, and production has been increased largely. A road has been built from the mine, which is at an elevation of 8,000 feet, to Basalt. The officers of the company are Peter Buol, Los Angeles, Calif., president; E. P. Thomas, Bakersfield, Calif., secretary-treasurer; and Walter J. Childers, general superintendent in charge of operations. The company is incorporated under the laws of Nevada for 200,000 shares of \$1 par value. The following description is taken from the Nevada Mining Press.⁹

The ore is a hot-water deposit, occurring in sandstone and opalite, and is of great extent. The richest ore is in the sandstone. It is mined by glory-hole methods, no powder being required. The bed is 60 to 80 feet thick above the present level at the crusher with a proved area of 400 feet by 400 feet. In excavating for the furnace floor, over 100 feet below the crusher level, good ore was opened. Ore also is exposed far below the furnace floor, insuring a supply for many years. The ore runs northeasterly and southwesterly with a pitch of around 60° to 70° to the northwest. The deeper deposits can be mined through a tunnel driven southerly from a canyon north of the present workings. The plant is treating 50 to 60 tons a day, producing 4 to 6 flasks.

The Good & McKinney property, also in Esmeralda County, is the old Container property (Container, Container No. 1, and Two Pines claims), formerly operated by G. B. Mills who sold it to Good & McKinney. The deposit is on the east slope of the White Mountains, a few miles east of Mount Montgomery. The mine is above Fish Lake Valley about 72 miles southwest of Tonopah. Some of the ore runs as high as 120 pounds of mercury to the ton, and the average has been 80 pounds. A considerable quantity of low-grade furnace ore, carrying 30 pounds, has been developed. A Cottrell batch tilting furnace has been installed. The Red Rock cinnabar mine (in the White Mountains, Esmeralda County, west of Fish Lake Valley), which adjoins the Container mercury mine owned by Good & McKinney, in the fall was producing 2 flasks a day. The ore assayed 3½ per cent mercury. About 1,000 tons of ore, averaging approximately 1 per cent, was on the dumps.

The Steamboat Springs cinnabar property, spread over 100 acres of land 10 miles south of Reno, covers a surficial deposit of ore. It lies along the big fault that is marked across Nevada and into California by hot springs which have long enjoyed a reputation for curative properties and which contain mercury in solution. The ore is

⁹ Nevada Mining Press, Big Rotary Furnace at B & B Quicksilver Mine Produces 120 Flasks of Mercury Each Month: Vol. 11, No. 443, Nov. 23, 1928, p. 1.

associated with these springs. The mine is within 2 miles of the Reno-Carson Highway and the Virginia & Truckee Railroad. The five patented claims included in the property are the Lafayette Division, Horseshoe, Mary Ann, Gladstone, and New Denmark. In the second week of April, 1928, the property was sold by Jerry Sheehan (a Reno banker) for \$5,000 to W. C. Smith, of Los Angeles and his associates, who formed the Steamboat Springs Mining Co., of which W. C. Smith is president, Merlin L. Cox, of Los Angeles, is vice president, D. F. Meiklejohn is secretary and manager, and F. E. Meiklejohn is resident agent. The capital stock is \$500,000 represented by 1,000,000 shares, par value 50 cents. It is proposed to mine the ore with a power shovel. The mill will have a capacity of 200 tons a day. The ore will be ground in water in a Hardinge ball mill, will then be concentrated by flotation, and will finally be sent to a 12-tube Johnson-McKay retort. The cinnabar separates readily from the quartz particles in the ball mill; 50 per cent of the pulp can be removed immediately in the form of a coarse product containing 97.8 per cent silica. The classified overflow will pass directly to Kraut flotation machines which are expected to recover 95 per cent of the cinnabar in the first concentrate, which should not be richer than 600 pounds of mercury to the ton. Fifty separate tests indicate that the best results are obtained by using 1.1 pounds of T & T mixture, 0.01 pound of potassium xanthate, and 0.01 pound of cresylic acid to the ton, at a cost for reagents of 5 to 8 cents per ton of ore treated.

The Castle Peak Quicksilver Co. is developing a cinnabar property in Storey County 8 miles east of the Steamboat Springs property, 15 miles southeast of Reno and $5\frac{1}{2}$ miles north of Virginia City, in the Virginia Range. The property consists of four claims lying $2\frac{1}{2}$ miles off the Virginia Railroad and 8 miles from the Reno-Carson Highway and the Virginia & Truckee Railroad. The company is a Nevada corporation financed by Iowa interests, represented on the board of directors by B. T. Dow and P. A. Bendixen, of Davenport. The capital stock is \$200,000, represented by 20,000 shares, par value \$10. H. E. Loufek, of Reno, is the president and manager, and Roy Stoddard, a Reno attorney, is secretary-treasurer.

The ore occurs in a soft, kaolinized andesite of unknown depth and has been operated in tunnels and drifts over an area 100 by 122 feet, at an average depth of 40 feet. This block of ground, in which development has been centered, was estimated in July, 1928, to contain 25,000 tons of ore, averaging 18 pounds a ton. Since then the work has been extended, and a shaft has been sunk 40 feet in ore near the south end of the ore-bearing formation. A tunnel was driven to develop a surface 390 feet north of the main workings, with gratifying results. The adit struck ore 45 feet sooner than was expected and has advanced 20 feet in ore of low grade, 5 to 7 pounds a ton. The tunnel is in 50 feet, and 65 feet farther in it will reach a point under a higher-grade deposit, opened on the surface, with 130 feet of backs. The tunnels and drifts are counted upon to increase the tonnage greatly, as the nature of the formation indicates that the ore will probably be continuous between this point and the older workings. (For further description of the geology, see Nevada Mining Press, vol. 10, July 6, 1928, pp. 1-4.)

The property of the Flower Quicksilver (Inc.) adjoins the Kernick divide, near Belmont, Nye County. W. A. Flower is the general manager of the company, which is financed largely in Reno. Two D retorts which have a rated capacity of 3 to 4 flasks a week, are in operation at the mine. The ore runs from 40 to 100 pounds to the

ton. It is mined through a shaft and hauled down the hill to the canyon where the plant is installed. A supply of oil fuel has been stocked, and water is piped from a spring up the canyon. Owing to the high-grade ore some trouble was had at the start with the condensers, which are 16 feet long and water-cooled, but which can be lengthened while the plant is in operation. One special feature is the elimination of the danger of the workers becoming salivated. An air jet is sent into the condensers, creating a draft through the retorts, so that no gases can come through the peep holes or around the retort doors.

Toward the latter part of the year the Raymond Van Ness mining property was opened between Belmont and Manhattan, Nye County, in what is known as the Spanish Belt mining district. This property, which lies 6 miles south of the Flower mercury deposits, is on a granite contact. The ore is in the granite and the shale. A 30-foot shaft exposed 4 to 6 feet of ore which is expected to yield 5 per cent of mercury. A trench 100 feet from the original point of discovery opened up a parallel ore body 6 feet in width, showing a content of about 7 per cent. A 2-mile road has been built from the old Barcelona mine to this property, which is at an elevation of 8,000 feet. A reduction plant was to be in operation before winter set in. In the fall some rich ore was exposed on the Sentinel property, 4 or 5 miles northeast of Manhattan, of which C. E. Van Ness is lessee.

The deposits of the Pilot Mountains in Mineral County have been described by Foshag.¹⁰ The Drew mine and the Mina property were under option to Los Angeles operators. These mines have both been worked off and on for 10 or 12 years, employing retorts or small hearth furnaces. It is said that large quantities of low-grade ore which can be treated profitably in a modern rotary furnace have been developed. Betty & Messenger, of Los Angeles, installed two D retorts on the Red Wing group of 16 claims on the south flank of Cinnabar Mountain at an altitude of 7,800 feet and about 2 miles from the Mina-Tonopah road. The distance to Redlich, a station on the Tonopah & Goldfield Railroad, is 12 miles and the distance to Mina is 25 miles.

At Castle Rock, a gold camp 35 miles west of Tonopah, a retort was installed late in the year by Charles A. Hendel, E. H. Nelson, and Peter Reuse to treat ore (some as high as 10 per cent) found in stringers of rhyolite. In the Diamondfield district in southern Nevada the All Metals Development Corporation early in 1928 took over the six Hillsborough claims from John Nay. In Dunlap Canyon south of Cinnabar Mountain James T. Kane opened up ore containing 5 to 25 per cent of mercury in a 10-foot shaft. In March Summerfield & Thompson had an option on the property. Monroe Thomas, a Fallon rancher, reported the discovery of a deposit of cinnabar about 150 feet wide on the surface near the hot springs 18 miles east of Fernley, on the Victoria Highway. In the Midas district (Gold Circle district) early in 1928 C. G. Dennis, of the Mercury Mining Co., planned development work upon a group of cinnabar claims southeast of Midas, owned by F. M. Williams. The ore is a hot-water deposit in opalite and will average, it is believed, 1 per cent of mercury. The Mercury Mining Co., of which F. W. Bradley of San Francisco is

¹⁰ Foshag, William F., Quicksilver Deposits of the Pilot Mountains: U. S. Geol. Survey Bull. 795, 1928, pp. 113-123.

president, optioned a cinnabar property, owned by Frank W. Stall and H. W. Gear, in Canyon Creek southeast of National, Humboldt County. The locations are on patented grazing land owned by the Utah Construction Co.; the patent, however, did not carry with it title to the minerals. Stokes & Wingert were developing a rich deposit near the water hole called Ned's Cache near Quinn's Canyon in the northwest corner of Lincoln County, 85 miles east of Tonopah by the old Pioche road by way of Stone Cabin. The World Exploration Co. (Chester R. Bunker, president), of Fort Worth, Tex., put to work a small force of miners on the 190-foot level of the Hannapah mine, east of Tonopah. About the middle of the year Clyde A. Garrett reported the discovery of cinnabar 1 mile north of Ione, northeastern Nye County and about the same distance from the old mine worked by the Mercury Mines Co. about 15 years ago. Early in 1928 E. L. Burney secured a lease and bond on the Bald Mountain property of 6 claims (55 miles northeast of Eureka, in the Diamond Range, northwestern White Pine County) from Al Dees, of Eureka. Burney has two D retorts in operation, each reported capable of treating 700 pounds of ore in 12 hours and using wood, coal, or oil for fuel.

OREGON

The leading mercury mines in Oregon, as judged by production in 1928, are the Opalite mine of the Mercury Mining Syndicate in Malheur County and the Blackbutte property of the Quicksilver Syndicate in Lane County. The Beardsmore Mining Co. in Crook County and the Consolidated Quicksilver Co. also produced in 1928. At the Blackbutte Mine the Quicksilver Syndicate was driving a 1,000-foot tunnel to cut the vein 850 feet below the present 900-foot level. The new tunnel, at about the same level as the treatment plant, is expected to handle the entire output of the mine, thus cutting transportation costs and doing away with the cable tramway. The company, which had installed a 100-ton Gould rotary furnace, was installing an additional unit of the same size; this unit was to be ready for operation about April 1, 1929. There was a Scott furnace already on the property. The Opalite property was described in the chapter of this series for 1927. In December, 1928, the power plant was destroyed by fire at a loss of \$75,000. This fire necessitated the closing of the plant which had been in operation only a little over a year. The rotary furnace was saved. At the Force mine near Gold Hill the Quicksilver Producers, a Washington corporation, was installing a 100-ton rotary furnace. E. G. Kingwell, secretary of the Sutherlin Chamber of Commerce, acquired an option on the Nonpareil cinnabar mines of the Oregon Silver & Cinnabar Mining Co., east of Sutherlin. These old mines have long been inactive, and the shafts and workings need extensive repairs.

TEXAS

In 1928, as in previous years, all the mercury produced in Texas was from ore mined in Brewster County. Available information with regard to the geology of and the operations in the Terlingua district was reviewed in the chapter of this series for 1927. A newspaper report credits the Chisos mine with having produced in its 39

years of life mercury worth almost \$12,000,000. The metal is hauled from Terlingua to Marathon, 90 miles away, in 12-mule-team wagons. F. Warren Oakes, jr., operated the "39" mine. Further prospecting was done on the Waldron property. The Mariscal, Oakes, and Boquillas properties, idle for several years, were reopened early in 1929. In the Big Bend section, 75 miles south of Marathon and 50 miles east of the Terlingua district, mercury was mined by the Brewster Quick-silver Consolidated. An announcement of special interest is that relating to a proposal to extend the Kansas City, Mexico & Orient Railroad from Alpine to Presidio. Such an extension would reduce the wagon haul on mercury and supplies from 80 to 35 miles.

WASHINGTON

The Barnum McDonell Mercury Co. and the Morton Cinnabar Co. (Fisher Mercury Mining Co.'s mine), in Lewis County, produced mercury in 1928.

WORLD PRODUCTION

World production of mercury, 1924-1928, by countries

[Compiled by L. M. Jones, of the Bureau of Mines]

[1 metric ton=29.395 flasks]

Country ¹	1924		1925		1926		1927		1928	
	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons	Flasks	Metric tons
Algeria.....	79	2.7	55	1.9	76	2.6	29	1.0	(²)	(²)
Austria.....	132	4.5	170	5.8	173	5.9	162	5.5	135	4.6
Canada.....					6	.2				
China ³	85	2.9	97	3.3	59	2.0	(²)	(²)	(²)	(²)
Czechoslovakia.....	2,287	77.8	2,158	73.4	2,419	82.3	1,623	55.2	2,114	71.9
Italy.....	48,237	1,641.0	53,898	1,833.6	54,998	1,871.0	58,672	1,996.0	58,446	1,988.3
Mexico.....	1,078	36.7	1,138	38.7	1,335	45.4	2,384	81.1	2,569	87.4
New Zealand.....							21	.7		
Rumania.....	8	.3	97	3.3	59	2.0	105	3.6		
Russia ⁴	1,019	65.3	291	9.9	3,727	126.8	2,175	74.0	(²)	(²)
Spain.....	26,417	898.7	37,546	1,277.3	46,861	1,594.2	73,281	2,493.0	64,525	2,195.1
United States.....	10,085	343.1	9,174	312.1	7,642	260.0	11,276	383.6	18,108	616.0
	90,327	3,073.0	104,624	3,559.3	117,355	3,992.4	149,728	5,093.7	(²)	(²)

¹ In addition to the countries shown in the table Turkey is a producer of mercury. Information furnished on May 21, 1923, by the United States High Commissioner of Turkey places this country's average annual production at approximately 67 tons (1,969 flasks). These figures are not included in the above totals.

² Data not available.

³ Exports. Statistics of production are not available; official estimates of the output in 1925 range from 128 to 470 metric tons.

⁴ Year ended Sept. 30.

The sources of world supply of mercury have been summarized,¹¹ as follows:

While the sources from which the world draws the larger part of its supplies of mercury are extremely limited in number, they are of such magnitude that the world's needs can be easily supplied for many years. Fully 70 per cent of the present output is derived from three mines—one in Spain, one in Italy, and one in the United States. It is of interest that these three countries have largely supplied the world's demands for more than 100 years, and that the reserves of the Almadén mine of Spain are alone sufficient to meet the present demand for

¹¹ Furness, J. W., and Jones, L. M., Mineral Raw Materials: U. S. Bur. of For. and Dom. Commerce, Trade Promotion Ser. 76, 1929, pp. 203-204.

more than 100 years. Deposits of mercury of minor importance are found in Algeria, China, Czechoslovakia, Japan, Mexico, Rumania, and Russia, the largest being probably those in China. The mining of mercury is a very old industry in China and during the nineteenth century it had an output amounting at times to 1,000 tons a year. During the years under consideration only small quantities of mercury have been produced in China and the consumption has been satisfied in part by imports. Data are not available for estimating the reserves or showing conclusively the tenor of the ore treated. Peru at one time furnished a large part of the world's production of mercury and contained a well-known deposit situated at Huancavelica called the Santa Barbara mine. The property was worked first in 1556 and is said to have produced more than 1,469,000 flasks up to 1900. During the period 1923 to 1925 a large amount of development work was done on the property, and in 1925 it was determined, from the exploratory work done, that it did not contain sufficiently large quantities of commercial ore to warrant exploitation. For many years Mexico has been a producer and exporter of mercury; it ranks fifth as a world's producer and will probably maintain this position for several years. Its production and reserves, while large in comparison with the smaller producers of the world, are insignificant by comparison with those of Spain or Italy.

FOREIGN SOURCES

SPAIN

Prior to 1920 Spain had been for many years the leading producer of mercury. In 1928, 2,195.1 metric tons of metal (64,525 flasks of 75 pounds each) was produced in Spain from 48,507 metric tons of ore. Approximately 2 per cent of the Spanish output of ore comes from a property in the Province of Granada, but by far the greater part of the output is derived from government-owned mines in the Province of Ciudad Real in central Spain. The Almadén mine, on the north slope of the Sierra Morena, is the largest and richest deposit in the world and has been worked for 2,000 years. It employs tools and methods at least 2 centuries old. The mine has been developed to a depth of 1,300 feet through a circular walled shaft, but operations have been confined to one of three veins—the San Francisco, in which the ore body is developed for a length of 1,000 feet and to a maximum width of 20 feet. A great deal of the ore in the Almadén mine runs as high as 20 per cent (400 pounds to the ton), and the average since 1801 has been 8 per cent. Metallic mercury is found in many places in the mine, but much of it is lost in mining.

Every year the Administrative Council of Mines of Almadén and Arrayanes permits Spanish and foreign firms to bid for the contract to sell the the mercury output of Almadén during the next fiscal year. The contract went in 1928 (the fourth consecutive year) to the Mercury Society of Spain. As this mine is under the direct supervision of the Administrative Council of Mines of Almadén and Arrayanes and as the distributing agency, the Mercury Society of Spain, although believed to be a private enterprise is nevertheless controlled by the Credit Bank of Spain, it has been considered that the Spanish Government controlled not only the output but to a limited extent the price also. Strictly speaking, however, sales to consumers were controlled by private individuals until June 23, 1928, when the sales agreement between the Spanish interests and the Italian Government became effective.

The following table shows the marked decrease in the exports of mercury from Spain to the United States.¹²

¹² Oil, Paint and Drug Reporter, vol. 115, Mar. 18, 1929, p. 60.

Mercury exported from Spain to the United States, 1924-1928

Year	From Alicante		From Madrid	
	Pounds	Value	Pounds	Value
1924.....			80,716	\$46,212
1925.....	206,250	\$165,489	623,346	506,910
1926.....	252,700	229,549	884,265	816,825
1927.....	507,680	510,194	586,216	880,219
1928.....	91,200	130,912	330,908	456,166

Mercury produced in Spain, 1926-27

Province	Number of mines	Workmen		Ore mined		Metal produced		
		At mines	At plants	Metric tons	Tenor (per cent)	Flasks	Value ¹	Flasks per man
1926								
Ciudad Real.....	1	877	366	29,131	5.23	46,703	\$2,591,545	37.57
Granada.....	3	24	8	877	.95	158	8,586	4.94
	4	901	374	30,008	5.10	46,861	2,600,131	36.75
1927								
Ciudad Real.....	1	756	336	50,122	5.73	72,988	4,637,996	66.84
Granada.....	3	18	15	1,233	.95	293	20,615	8.88
	4	774	351	51,353	5.62	73,281	4,658,611	65.14

¹ Exchange rate of peseta: 1926, 14.896 cents; 1927, 17.0592 cents.

ITALY

Upon the acquisition of the major deposits of Austria-Hungary Italy became the second largest source of mercury and for a number of years (1920-1926, inclusive) produced actually more than Spain. In 1928 the output of Italy was 1,988.3 metric tons (58,446 flasks of 75 pounds each), a reduction from the 1,996 tons (58,672 flasks) produced in 1927. The average yield of the ore treated decreased from 0.905 per cent in 1927 to 0.868 per cent in 1928. In addition to selling current production, Italian producers disposed of large reserve stocks during the year.

Although there are six other mercury mines of importance in Italy, the principal producing areas are the Monte Amiata district and the Idria district, the former containing the famous Abbadia San Salvatore mine operated by the Società Monte Amiata.

The property of the Società Monte Amiata, in Tuscany, is privately owned and operated and can probably maintain its present rate of production for about 20 years. Regulations for the purchase of any quantity of mercury produced by the company are set forth in a circular obtainable from the firm. The usual procedure is to apply for quotations to the company in Rome by cable.

Mercury deposits were discovered at Idria, in Carniola, in 1470 and were worked from that time until 1920 by the Austrian Government. The Idria mine is now operated by the R. Miniera di Idria, which is owned and controlled by the Italian Government through the Banca Commerciale. The ore has been worked over a length of almost

5,000 feet, but it apparently does not extend beyond a depth of 1,000 feet. At present the average content of the ore treated is 0.77 per cent of mercury. The Idria district is said to be rapidly reaching exhaustion. Sales were handled from the office in Trieste or from the Government department, the R. Intendenza della Finanza, at Rome.

Mercury produced in Italy, 1926-27

Province	Number of mines	Workmen		Ore mined		Metal produced		
		At mines	At plants	Metric tons	Tenor (per cent)	Flasks	Value ¹	Flasks per man
1926								
Friuli (Trieste)	1	830	136	78,430	0.77	14,286	\$945,027	14.79
Grosseto.....	4	465	206	44,093	.51	6,320	418,068	9.42
Roma.....	1	26	-----	2,800	.60	(²)	(²)	(²)
Siena	3	1,016	577	103,101	1.18	34,392	2,275,065	21.59
	9	2,337	919	228,424	.90	54,998	3,638,160	³ 17.03
1927								
Gorizia (Trieste).....	1	840	136	83,678	.77	14,668	1,299,666	15.03
Grosseto.....	6	496	200	41,601	.52	6,378	575,262	9.16
Roma.....	1	16	-----	1,600	.60	(²)	(²)	(²)
Siena	3	1,031	597	112,455	1.15	37,626	3,395,137	23.11
	11	2,383	933	239,334	.91	58,672	5,270,065	³ 17.78

¹ Exchange rate of lira: 1926, 3.839 cents; 1927, 5.156 cents.

² Ore produced but no extraction of metal reported.

³ Exclusive of the workmen in the Roma district, for whom no output of metal was reported.

In 1928 Italy exported 2,126 metric tons of mercury, valued at 118,254,901 lire. The following excerpt is from a report by Sydney B. Redecker, American consul, Naples, Italy, dated July 18, 1928.

Quality of Italian ore.—The Italian ore is reported to be of a higher quality than that in the United States. Whereas American ore averages 0.5 per cent quicksilver metal, the Austrian ore 0.65 per cent, and the Spanish ore 8 per cent, that of Italy runs about 0.9 per cent. Owing to the higher-grade ore and lower labor charges, production costs in Italy are below those in the United States.

Italian exports of mercury.—Although 1927 registered a higher production of mercury in Italy than any previous year, the Italian exports of this metal in that year declined to only 1,347 tons (compared with 1,808 tons in 1926), or an amount lower than the exports for any previous year. It is undoubtedly because of this decline in export sales, as compared with the appreciable increases in production, that Italian producers sought an agreement with Spanish producers, establishing restricted production and uniform sales price. The following table shows the total exports of mercury metal from Italy each of the last five years.

Mercury exported from Italy, 1923-1927

Year	Metric tons	Value (lire)
1923.....	1,406	37,064,207
1924.....	1,669	48,055,848
1925.....	1,507	62,204,413
1926.....	1,808	90,792,739
1927.....	1,319	69,651,578

The following table shows the exports of mercury metal from Italy during the first three months of each of the last three years.

Mercury exported from Italy in first quarter of year, 1926-1928

First quarter	Metric tons	Value (lire)
1926-----	418	17, 302, 766
1927-----	448	22, 465, 204
1928-----	304	17, 080, 218

Distribution of Italian exports.—The United States is the leading importing country of Italian mercury, that country during recent years taking somewhat less than one-fourth of the total Italian production exported abroad. The extent of America's purchases of Italian mercury have varied during recent years in accordance with the general trend of the total volume of Italian exportation, the percentage going to America being slightly less than one-quarter of the total. The exports of mercury from Italy to the United States in 1927 amounted to 3,020 quintals.

The second most important purchaser of Italian mercury in 1927 was Germany, which country took 2,874 quintals, followed by Great Britain with 1,674 quintals and by Japan with 1,421 quintals.

The following table shows the distribution of Italian mercury during each of the last three years.

Mercury exported from Italy, 1925-1927, by destinations, in metric quintals (220.4 pounds)

Country of destination	1925	1926	1927	Country of destination	1925	1926	1927
Austria-----	298	81	65	India, British-----	960	1, 087	599
France-----	961	1, 042	851	United States-----	3, 557	4, 464	3, 020
Germany-----	3, 003	4, 069	2, 874	Other countries-----	1, 401	1, 837	2, 209
Great Britain-----	2, 086	1, 718	1, 674				
Japan-----	1, 511	2, 599	1, 421		15, 074	18, 085	13, 472
Hong Kong-----	1, 297	1, 188	759				

Importance of Italian production in American import trade.—In 1926 Italy was the second most important supplier of mercury to the United States, ranking only after Spain and furnishing to the United States a total of 882,589 pounds of mercury valued at \$830,781 compared with Spain's amount of 1,058,775 pounds valued at \$966,368. During previous recent years, with the single exception of 1923, however, Italy was easily the most important single supplier of mercury to the United States, furnishing quantities considerably in excess of Spain, its only other important competitor.

MEXICO

Beginning with 1926 the high prices of mercury have stimulated interest in mercury mining. In 1927 the output of mercury in Mexico was 81.1 metric tons, an increase of 79 per cent over that of 1926; in 1928 it advanced to 87.4 metric tons. More than 450 concessions were granted in 1928, chiefly in San Luis Potosí, Zacatecas, Guerrero, and Chihuahua.

From 1896 to 1920, inclusive, Mexico produced 4,325 metric tons of mercury, an average of 173 tons a year. The largest output was in 1898, when 353 tons was produced; the smallest was 33 tons in 1917. From 1921 to 1926 the output ranged from 37 to 46 tons annually. During these years a large part of the mercury produced came from the dumps of the old metallurgical works of Patio, Pachuca Hidalgo, Fresnillo, Zacatecas, and Guanajuato. Previous to the introduction of cyanidation great quantities of mercury were consumed in Mexico

in the treatment of silver ores by the patio or panamalgamation processes. About 1857 Mexico was using 700 tons annually for the recovery of 450 tons of silver. Most of the mercury required was imported from Spain; in 1844 the Mexican output was 69 tons, whereas the consumption was 647 tons.

The history and development of mercury production in Mexico are described at length by Segura¹³ in a comprehensive article recently published. Most of the Mexican deposits have proved superficial and short-lived. The following notes are abstracted from the article by Segura.

A brief study of distribution shows that various classes of mercury ore are found in the States of Aguascalientes, Chihuahua, Durango, Guanajuato, Guerrero, Hidalgo, Jalisco, México, Michoacán, Morelos, Nayarit, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sonora, Tlaxcala, and Zacatecas, but explorations and exploitations of mercury have been made in the States of Durango, Guanajuato, Guerrero, Jalisco, México, Michoacán, Morelos, Querétaro, San Luis Potosí, and Zacatecas.

It is likely that the deposits of mercury in Mexico follow general directions, one along the Sierra Madre Occidental, from the State of Sonora to the State of Oaxaca, and another from northeast to southwest, crossing the States of San Luis Potosí, Querétaro, México, Michoacán, Guanajuato, and Guerrero. In the last-mentioned section the most important beds of the country are localized, which are those of Huitzoco, State of Guerrero, and Guadalcázar, State of San Luis Potosí. The deposits of Guadalcázar are the most important in the country because they have furnished an enormous quantity of mercury and have been exploited with success in different epochs. Guadalcázar is about 100 kilometers to the northeast of the capital of the State and is connected with the station of Villar by the railroad from San Luis to Tampico.

It is known that deposits in the State of Chihuahua were discovered recently near the frontier of the United States, but there is no definite information concerning the situation and importance of the beds.

In the State of Tamaulipas, at Altamira, 26 kilometers from Tampico, metallic mercury has been found in 14 places. The ground between these places is barren. The mercury appears in large drops on the surface, but these diminish in size and eventually disappear entirely at a depth of 2 meters. The deposit is the more remarkable because it does not seem to be an isolated one. At a distance of 8 or 10 leagues up the lake and at equal intervals north or northwest, other deposits of metallic mercury have been found. It is believed that these accumulations are the result of mishaps to the mercury that, when brought in from Spain, was transported on the backs of natives or of mules to the silver mines of the country. Altamira was the old port where the ships of Spain docked. The 8 or 10 leagues to the next "depot" is a day's journey for a pack train. There the mercury was again exposed to the dangers of unloading. The other points at which the metallic mercury was found are on the same trail up to the famous and, in ancient times, rich mining camps of Catorce, Charcas, Zacatecas, Fresnillo, Parral, and others. As the transportation of this metal lasted for centuries, this explanation seems reasonable.

CANADA

Prospecting and some development work were done on cinnabar properties in the Bridge River area of the Lillooet mining division and in the Kamloops mining division of British Columbia. This ore of mercury occurs also in the Alberta mining division of Vancouver Island. The Kamloops Lake deposits are of almost too low grade to be profitably mined. The output shipped in 1926-27 was only 6 flasks. Production in Canada is as yet unimportant.¹⁴

¹³ Segura, David, *El Mercurio en Mexico*: Bol. Min., vol. 26, No. 1, July, 1928, pp. 16-49.

¹⁴ Eardley-Wilmot, V. L., Notes on the Quicksilver Occurrences in Canada: Canadian Dept. Mines, Mines Branch No. 687, 1928, pp. 53-57.

AUSTRALIA

A proposed consolidation of the Australian Quicksilver Mining Co., N. L., and the New Jamieson Quicksilver Mines, N. L., after a meeting of the shareholders in the Australian Quicksilver Mining Co. on September 21, 1928, was postponed for the purpose of obtaining better terms. The terms and conditions recommended were that a new company be formed, with a nominal capital of £60,000 in shares of £1 each, of which 20,000 would be fully paid, 30,000 would be contributing at 2s. on application, covering allotment, and 10,000 would be held in reserve. It was proposed that the Australian Quicksilver Co. should receive 13,000 fully paid shares and the New Jamieson Co. 7,000 fully paid shares. In the new company the New Jamieson Co. was to have representation on the board. A committee of five shareholders was appointed to discuss terms with both boards.

NEW ZEALAND

The mercury deposits of New Zealand have been developed and worked intermittently for some years. The principal occurrences are at Puhipuhi and at Ohaeawai, in the northern part of North Island. In 1917 the New Zealand Quicksilver Co. was formed to take over the Whangarei Cinnabar Co.'s plant and bases at Puhipuhi.

During the period of the World War the Whangarei Co. produced £8,000 worth of mercury. The successor to this company produced 11,296 pounds of mercury in 1918 but later experienced difficulties and ceased operations in 1922.

R. H. Goodwin, a British metallurgist who has had considerable experience with mercury in Asia Minor and elsewhere, has for some months been investigating the New Zealand deposits for the Imperial Chemical Industries (Ltd.), of which Nobels is an associated company. It is reported that the company has acquired a property at Ngawha, near Ohaeawai, and will proceed immediately with its active development.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA

(MINE REPORT)

By V. C. HEIKES ¹

SUMMARY

The total value of the mine production of gold, silver, copper, and lead in California in 1928 was \$15,381,783, a decrease of 9 per cent as compared with 1927. The production of gold declined 8 per cent. The output of silver was 9 per cent less in quantity and 6 per cent less in value than in 1927. The production of copper decreased 7 per cent in quantity but increased 2 per cent in value. The output of lead decreased 30 per cent in quantity and 36 per cent in value. No zinc was reported produced in the State in 1928. The mine production of metals came from 32 counties in both 1927 and 1928. Merced and San Luis Obispo Counties produced in 1928 but not in 1927, and Monterey and Napa Counties produced in 1927 but not in 1928.

The value of the metals produced from 287 lode mines in 1928 was \$10,521,086, a decline of 4 per cent as compared with the output of 318 lode mines in 1927. Gold produced at lode mines in 1928 (\$5,934,686) was 2 per cent more than in 1927, and silver (1,461,560 ounces, valued at \$855,013) was 9 per cent less in quantity and 6 per cent less in value. The quantity of ore, old tailings, etc., handled at lode mines in 1928 was 1,702,541 short tons, or 12 per cent more than in 1927. The ore, old tailings, etc., treated averaged \$6.16 in recovered metals to the ton in 1928, compared with \$7.19 in 1927; the ore averaged \$6.55 in 1928 and \$7.38 in 1927, and the old tailings, etc., averaged \$1.15 in 1928 and \$3.52 in 1927.

Of the 287 lode operations 218 yielded dry gold ore, 15 dry silver ore, 16 copper ore, 18 lead ore, and 1 lead-copper ore; the remaining 19 were on old dump material, tailings, mill clean-up, etc.

The total value of gold and silver produced by 460 placer mines in California in 1928 was \$4,860,697, or 17 per cent less than the output of 465 placer mines in 1927. The placer gold production was \$4,850,629, or 17 per cent less than in 1927. The quantity of silver recovered at placer mines in 1928 was 17,211 ounces, valued at \$10,068, a decrease of 18 per cent in quantity and 15 per cent in value compared with 1927. The placer operations were classed as follows: Dredges, 24; drift, 73; hydraulic, 76; and surface, 287.

J. M. Hill has critically reviewed, revised, and recompiled the available records on gold, silver, copper, lead, and zinc produced from California ores and gravels from 1848 to 1928, inclusive. He has arrived at the figure \$2,091,624,858 as the total value of such produc-

¹Helen M. Gaylord, of the Bureau of Mines, prepared the statistics for this report.

tion. For his compilation he has selected some quantities and unit values differing somewhat from figures heretofore used in various chapters of Mineral Resources of the United States; hence the following items by decades, quoted from his paper,² may not conform precisely to a summation of similar Mineral Resources data.

Gold, silver, copper, lead, and zinc in California, 1848-1928, by decades

Decade	Gold ¹			Silver ²	
	Placer	Lode	Total	Fine ounces	Value
1848-1850	\$51,669,767		\$51,669,767	353,000	\$465,960
1851-1860	581,561,868	\$5,874,362	587,436,230	4,017,000	5,402,865
1861-1870	211,388,439	23,487,604	234,876,043	1,755,000	2,342,925
1871-1880	120,910,077	51,818,604	172,728,681	6,152,000	7,530,048
1881-1890	37,881,328	113,643,986	151,525,314	12,899,017	13,540,200
1891-1900	29,416,001	117,664,005	147,080,006	6,012,310	4,139,070
1901-1910	63,569,813	118,337,674	181,907,487	12,848,365	7,372,497
1911-1920	84,739,988	107,249,344	191,989,332	15,680,607	11,648,499
1921-1928	45,778,123	58,571,377	104,349,500	22,019,753	17,195,508
	1,226,915,404	596,646,956	1,823,562,360	81,737,052	69,637,572

Decade	Copper ³		Lead ⁴		Zinc ⁵		Total value ⁶
	Pounds	Value	Pounds	Value	Pounds	Value	
1848-1850							\$52,135,727
1851-1860							592,839,095
1861-1870	19,130,000	\$6,681,810					243,900,778
1871-1880	4,132,000	936,232	65,214,000	\$3,531,370			184,726,331
1881-1890	8,047,834	1,234,010	24,480,000	1,088,300			167,387,824
1891-1900	91,293,128	13,669,971	10,013,900	375,085			165,264,132
1901-1910	325,162,456	47,553,335	10,327,122	477,678	439,550	\$26,345	237,337,342
1911-1920	361,685,828	71,644,845	70,918,299	4,910,542	55,022,707	5,950,996	286,144,214
1921-1928	247,322,782	34,062,710	41,019,062	2,947,018	46,904,883	3,334,679	161,889,415
	1,056,774,028	175,782,913	221,972,333	13,329,993	102,367,140	9,312,020	2,091,624,858

¹ Gold figures, 1848-1883, from table compiled by C. G. Yale and published in 13th Ann. Rept. of the California State Mineralogist; figures, 1884-1902, from mint agents' statements in the annual reports of the Director of the Mint; figures, 1902 to date, from annual chapters, Gold, Silver, Copper, Lead, and Zinc in California, published in Mineral Resources of the United States.

² Silver figures, 1848-1880, by decades, estimated by J. M. Hill (see discussion "Sources of silver production"); figures, 1891-1903, from mint agents' statements in the annual reports of the Director of the Mint (ounces and value calculated from original figures given as coinage value); figures, 1904 to date, from annual chapters, Gold, Silver, Copper, Lead, and Zinc in California, published in Mineral Resources of the United States.

³ Copper figures, 1862-1904, from chapter on Copper in Mineral Resources of the United States, 1915, Pt. I, p. 663; figures, 1905 to date, from annual chapters, Gold, Silver, Copper, Lead, and Zinc in California, published in Mineral Resources of the United States.

⁴ Lead figures, 1870-1876, estimated by J. M. Hill from various data; figures, 1877-1881, from chapter on lead in Mineral Resources of the United States, 1912, Pt. I, p. 339; figures, 1882-1886, from annual chapters on lead in Mineral Resources volumes; figures, 1887-1903, from 18th Ann. Rept. of the California State Mineralogist, p. 451; figures, 1904 to date, from annual chapters, Gold, Silver, Copper, Lead, and Zinc in California, published in Mineral Resources of the United States.

⁵ Zinc figures from annual chapters, Gold, Silver, Copper, Lead, and Zinc in California, published in Mineral Resources of the United States.

⁶ Value of gold, \$20.671835 a fine ounce. Value of other metals calculated from price table published in preface to the Metals volumes (Pt. I) of Mineral Resources of the United States.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper,

² Historical Summary of Gold, Silver, Copper, Lead, and Zinc Produced in California, 1848 to 1926: Econ. Paper 3, U. S. Bureau of Mines, 1929, p. 4.

lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Cop- per	Lead	Zinc	Year	Silver	Cop- per	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919	\$1.12	\$0.186	\$0.053	\$0.073	1924	\$0.670	\$0.131	\$0.080	\$0.065
1920	1.09	.184	.080	.081	1925	.694	.142	.087	.076
1921	1.00	.129	.045	.050	1926	.624	.140	.080	.075
1922	1.00	.135	.055	.057	1927	.567	.131	.063	.064
1923	.82	.147	.070	.068	1928	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in California, 1919-1928

Year	Mines produc- ing		Ore, tail- ings, etc. (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919	370	280	1,714,911	807,666.82	\$16,695,955	1,107,189	\$1,240,051
1920	301	199	1,165,022	692,296.70	14,311,043	1,706,327	1,859,896
1921	294	279	1,215,600	759,720.76	15,704,822	3,629,223	3,629,223
1922	283	282	1,539,933	709,677.99	14,670,346	3,100,065	3,100,065
1923	268	353	1,535,691	647,209.75	13,379,013	3,559,443	2,918,743
1924	267	266	2,019,200	636,139.72	13,150,175	3,555,133	2,381,939
1925	332	359	1,938,679	632,035.31	13,065,330	3,054,416	2,119,765
1926	335	483	1,760,859	576,798.40	11,923,481	2,022,460	1,262,015
1927	318	465	1,526,410	564,585.50	11,671,018	1,620,242	918,677
1928	287	460	1,702,541	521,739.59	10,785,315	1,478,771	865,081

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919	21,732,507	\$4,042,246	3,568,267	\$189,118	472,990	\$34,528	\$22,201,898
1920	12,626,272	2,323,234	4,813,510	385,081	1,165,509	94,406	18,973,660
1921	11,743,404	1,514,899	1,124,276	50,592	846,184	42,309	20,941,845
1922	22,539,485	3,042,830	6,312,536	347,189	3,012,950	171,738	21,332,168
1923	28,317,759	4,162,711	9,549,680	668,478	-----	-----	21,128,945
1924	52,107,171	6,826,039	4,763,806	381,104	3,060,000	198,900	22,938,157
1925	46,864,913	6,654,818	6,566,200	571,259	11,489,237	873,182	23,284,354
1926	33,466,299	4,685,282	8,093,513	647,481	20,433,887	1,532,542	20,050,801
1927	27,133,008	3,554,424	2,718,014	171,235	8,062,625	516,008	16,831,362
1928	25,150,743	3,621,707	1,891,037	109,680	-----	-----	15,381,783

Gold and silver produced at placer mines in California, 1919-1928

Year	Dredge				Drift			
	Gold		Silver		Gold		Silver	
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
1919	373,305.95	\$7,716,919	25,740	\$28,829	4,128.37	\$85,341	554	\$620
1920	333,805.20	6,900,366	28,918	31,521	3,044.00	62,925	374	408
1921	375,234.56	7,756,787	36,322	36,322	6,163.51	127,411	615	615
1922	241,837.04	4,999,215	16,608	16,608	12,220.79	252,626	1,391	1,391
1923	293,429.92	6,065,735	17,569	14,407	8,938.31	184,771	955	783
1924	208,279.59	4,305,521	14,793	9,911	4,768.22	98,568	560	375
1925	229,821.98	4,750,842	16,478	11,436	3,218.07	66,523	358	248
1926	239,482.59	4,950,545	17,287	10,787	5,381.06	111,236	942	588
1927	264,220.81	5,461,929	18,530	10,507	6,865.82	141,929	835	473
1928	214,345.43	4,430,913	14,510	8,488	7,420.05	153,386	799	147

Gold and silver produced at placer mines in California, 1919-1928—Continued

Year	Hydraulic				Surface				Total value
	Gold		Silver		Gold		Silver		
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value	
1919	8,941.25	\$184,832	1,249	\$1,399	2,224.48	\$45,984	381	\$427	\$8,064,351
1920	3,204.02	66,233	413	450	1,503.93	31,089	195	212	7,093,204
1921	7,875.84	162,808	864	864	5,215.70	107,818	829	829	8,193,454
1922	7,656.57	158,275	906	906	4,341.10	89,739	708	708	5,519,468
1923	5,409.68	111,828	626	513	7,752.06	160,249	1,155	947	6,539,233
1924	2,911.93	60,195	409	274	6,002.77	124,088	928	622	4,599,554
1925	8,482.30	175,345	958	665	5,003.61	103,434	785	545	5,109,038
1926	3,344.62	69,139	450	281	4,715.72	97,483	683	426	5,240,485
1927	5,845.25	120,832	700	397	5,448.14	112,623	838	475	5,849,165
1928	4,426.90	91,512	538	315	8,456.80	174,818	1,364	798	4,860,697

GOLD

The value of the mine production of gold in California in 1928 was \$10,785,315, or \$885,703 less than in 1927. Much of this loss was due to decreased output by the dredges. Lode mines yielded 55 per cent and placer mines 45 per cent of the total gold in 1928 as compared with slightly less than 50 per cent and slightly more than 50 per cent in 1927, 56 per cent and 44 per cent in 1926, 61 per cent and 39 per cent in 1925, and 65 per cent and 35 per cent in 1924, respectively.

Four counties (the same as in 1927) produced more than \$1,000,000 each in gold in 1928. Yuba, with \$2,304,377 in 1928 produced largely by dredges, was first in rank, as in 1927; Amador, with \$2,236,922 largely from lode mines, was second (third in 1927); Nevada, with \$1,994,002 mostly from lodes, was third (second in 1927); and Sacramento, with \$1,558,173 all from placers and mostly from dredging, was fourth, as in 1927. Other important counties, named in order of output of gold, were: Sierra, chiefly lode gold; Trinity, chiefly dredges; Plumas, chiefly copper mines; Stanislaus, entirely placer, chiefly dredges; Kern, almost all lode gold; and Calaveras, lode and placer.

The yield of gold from placer mines, according to the method worked, was divided as follows: Dredges, 91 per cent (94 per cent in 1927); surface, 4 per cent; drift, 3 per cent; and hydraulic, 2 per cent. Production of gold by the 24 dredges operating in 1928 (25 in 1927) was 19 per cent less than in the preceding year and came from Yuba, Sacramento, Trinity, Stanislaus, Shasta, Calaveras, and Butte Counties, named in order of output. Gold obtained by hydraulic mining in 1928 decreased 24 per cent compared with 1927, but the yield from drift and surface placers increased.

The output of gold from the lode mines was \$100,981 more in 1928 than in 1927, the only increase recorded in the lode gold yield since that of 1924 over 1923. Amador County made the largest increase in spite of the fact that a fire forced one of its large gold-producing companies to suspend operations during the last quarter of the year.

Gold ore and tailings sold or treated in 1928 yielded 93 per cent, copper ore and tailings 6 per cent, and silver ore 1 per cent of the total gold from lode mines, the same ratio as in 1927. Amalgamation mills in 1928 recovered 74 per cent, cyanidation plants 16 per cent, and smelt-

ers 10 per cent of the lode gold output of California as compared with approximately 75 per cent, 15 per cent, and 10 per cent, respectively, in 1927.

It is estimated that $3\frac{1}{2}$ per cent of the gold output from lode mines was stolen and sold by "high graders" in 1928 compared with 4 per cent in 1927 and 6 per cent in 1926.

In 1928 there were 26 companies in the State that produced more than 1,000 ounces of gold each, and they contributed nearly 90 per cent of the total gold output of the State; in 1927 there were 33 companies that produced more than 1,000 ounces each. Of the 26 larger companies 6 produced more than 20,000 ounces each and 2 more than 50,000 ounces each; 8 of them operated 20 dredges, 1 operated a drift placer, 1 operated a silver mine, 2 operated copper mines, 14 operated gold lode mines, and 1 operated a plant treating gold tailings. The 10 largest gold-producing companies in California in 1928, in order of output, were the Yuba Consolidated Gold Fields (6 dredges), Natomas Co. of California (6 dredges), Empire Mines & Investment Co. (gold lode), North Star Mines Co. (gold lode), Kennedy Mining & Milling Co. (gold lode), Original Sixteen to One Mines Co. (Inc.) (gold lode), Argonaut Mining Co. (gold lode), Central Eureka Mining Co. (gold lode), Walker Mining Co. (copper mine), and the Capital Dredging Co. (2 dredges).

The interesting history of the discovery of gold in California was recently reviewed in the University of California Chronicle.³

SILVER

The mine production of silver in California in 1928 was 1,478,771 ounces, valued at \$865,081, a decrease of 141,471 ounces in quantity and of \$53,596 in value as compared with 1927. The silver yield in 1928 brings the State back to the rank it held before the discovery of the famous California Rand Silver (Inc.) property in San Bernardino County, which had a production of over 2,000,000 ounces of silver for three consecutive years. Named in order of output, the silver-producing counties in 1928 were San Bernardino, Plumas, and Mono, with Shasta dropping to fourth place with an output of 67,403 ounces of silver compared with 123,917 ounces in 1927. Most of the silver yield of the State, aside from that from silver ore, came from copper ore mined in Plumas and Shasta Counties; gold ore and lead ore were next in importance as sources of silver.

The yield of silver from placer mines in 1928 was 17,211 ounces, 3,692 ounces less than in 1927 and slightly over 1 per cent of the total silver output of the State. Of the 1,461,560 ounces of silver produced at lode mines in 1928 dry silver ore yielded 63 per cent, copper ore and tailings 28 per cent, dry gold ore and tailings 6 per cent, lead ore nearly 3 per cent, and lead-copper ore a small quantity.

Thirty-seven companies in California produced 1,421,682 ounces of silver in 1928; no company was in the 1,000,000-ounce class and only one had an output of more than 500,000 ounces; 3 companies produced between 100,000 and 500,000 ounces, 5 between 10,000 and 50,000 ounces, 6 between 5,000 and 10,000 ounces, and 22 between 1,000 and 5,000 ounces. The 10 largest silver-producing companies in California in 1928, in order of output, were the California Rand

³ Rickard, T. A., The Discovery of Gold in California: Univ. California Chronicle, April, 1928, pp. 141-169.

Silver (Inc.), Mono Mining Co. of Nevada, Walker Mining Co., Engels Copper Mining Co., Mountain Copper Co. (Ltd.), North Star Mines Co., Island Copper Co., Montana-Tonopah Co., Empire Mines & Investment Co., and the Yuba Consolidated Gold Fields.

COPPER

The mine production of copper in California in 1928 was 25,150,743 pounds, or 1,982,265 pounds less than in 1927. Plumas County, with its two outstanding copper mines, produced 84 per cent, Shasta County 12 per cent, and Trinity County nearly 3 per cent of the total copper output of the State. Practically all of the copper produced came from copper ore, mine water, and tailings. With the increase in demand for and price of copper during the last quarter of the year, increased facilities for mining copper in California in 1929 were formulated.

In 1928 16 properties in California produced 900,791 tons of copper ore, which had an average assay content of 0.019 ounce of gold and 0.457 ounce of silver a ton, and 1.525 per cent of copper.

LEAD

The mine production of lead in California in 1928 was 1,891,037 pounds, a decrease of 826,977 pounds compared with 1927. Inyo, the chief lead-producing county, yielded 92 per cent of the total lead output of the State, Riverside County contributed 5 per cent, and San Bernardino County 2 per cent. The Ubehebe district, out from Keeler, was the chief source of the lead output.

In 1928 18 properties in California produced 3,401 tons of lead ore, which had an average assay content of 0.078 ounce of gold and 11.598 ounces of silver a ton, 0.440 per cent of copper, and 27.599 per cent of lead.

ZINC

No mine production of zinc in California in 1928 was reported. The mine production in 1927 was 8,062,625 pounds, valued at \$516,008.

Mine production of gold, silver, copper, and lead in California in 1928, by counties

County	Mines producing		Gold					
			Lode		Placer		Total	
	Lode	Placer	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Alpine.....	1		1.13	\$23			1.13	\$23
Amador.....	13	12	107,551.64	2,223,290	659.46	\$13,632	108,211.10	2,236,922
Butte.....	5	35	453.79	10,001	1,859.11	38,431	2,342.90	48,432
Calaveras.....	23	25	4,411.94	91,203	3,442.81	71,169	7,854.75	162,372
Del Norte.....		1			13.38	277	13.38	277
Eldorado.....	26	33	4,677.27	96,688	1,225.29	25,329	5,902.56	122,017
Fresno.....	1	3	15.63	323	732.00	15,132	747.63	15,455
Humboldt.....		8			86.48	1,788	86.48	1,788
Imperial.....	2		1.20	25			1.20	25
Inyo.....	25		521.54	10,781			521.54	10,781
Kern.....	19	2	8,999.45	186,035	20.20	418	9,019.65	186,453
Lassen.....	3		23.78	492			23.78	492
Los Angeles.....	3	1	55.87	1,155	49.92	1,032	105.79	2,187
Madera.....	5	3	159.38	3,295	13.80	285	173.18	3,580
Mariposa.....	19	7	5,713.10	118,472	101.38	2,096	5,832.48	120,568
Merced.....		3			14.98	310	14.98	310
Mono.....	4		305.09	6,307			305.09	6,307
Nevada.....	16	34	94,587.98	1,955,307	1,871.85	38,695	96,459.83	1,994,002
Placer.....	6	38	2,062.17	42,629	1,418.86	29,330	3,481.03	71,959
Plumas.....	10	36	15,243.86	315,119	847.31	17,515	16,091.17	332,634
Riverside.....	3		105.47	2,180			105.47	2,180
Sacramento.....		12			75,376.64	1,558,173	75,376.64	1,558,173
San Bernardino.....	24	5	4,399.19	90,939	37.62	778	4,436.81	91,717
San Diego.....	4	4	91.26	1,887	37.93	784	129.19	2,671
San Luis Obispo.....		3			35.09	725	35.09	725
Shasta.....	13	22	1,601.23	33,100	3,871.53	80,032	5,472.76	113,132
Sierra.....	11	30	31,117.42	643,254	1,528.71	31,601	32,646.13	674,855
Siskiyou.....	14	65	1,237.19	25,575	2,909.38	60,142	4,146.57	85,717
Stanislaus.....		6			9,466.17	195,683	9,466.17	195,683
Trinity.....	9	46	1,469.98	30,387	18,010.35	372,307	19,480.33	402,694
Tuolumne.....	26	7	1,662.95	34,376	117.60	2,431	1,780.55	36,807
Yuba.....	2	19	1,627.90	11,843	110,901.33	2,292,534	111,474.23	2,304,377
Total, 1927.....	237	460	287,090.41	5,934,686	234,649.18	4,850,629	521,739.59	10,785,315
	318	465	282,205.48	5,833,705	282,380.02	5,837,313	564,585.50	11,671,018

County	Silver					
	Lode		Placer		Total	
	Fine ounces	Value	Fine ounces	Value	Fine ounces	Value
Alpine.....		\$363			621	\$363
Amador.....	24,379	14,262	94	\$55	24,473	14,317
Butte.....	976	571	270	158	1,246	729
Calaveras.....	2,138	1,251	373	218	2,511	1,469
Del Norte.....			2	1	2	1
Eldorado.....	1,039	608	152	89	1,191	697
Fresno.....	5	3	123	72	128	75
Humboldt.....			12	7	12	7
Imperial.....	2	1			2	1
Inyo.....	40,937	23,948			40,937	23,948
Kern.....	8,956	5,239	10	6	8,966	5,245
Lassen.....	14	8			14	8
Los Angeles.....	19	11	15	9	34	20
Madera.....	239	140	7	4	246	144
Mariposa.....	3,743	2,190	16	9	3,759	2,199
Merced.....			3	2	3	2
Mono.....	301,052	176,115			301,052	176,115
Nevada.....	35,215	20,601	337	197	35,552	20,798
Placer.....	381	223	197	115	578	338
Plumas.....	326,627	191,077	98	57	326,725	191,134
Riverside.....	2,672	1,563			2,672	1,563
Sacramento.....			3,041	1,779	3,041	1,779
San Bernardino.....	620,063	362,737	7	4	620,070	362,741
San Diego.....	19	11	3	2	22	13
San Luis Obispo.....			2	1	2	1
Shasta.....	66,884	39,127	519	304	67,403	39,431
Sierra.....	6,032	3,529	144	84	6,176	3,613
Siskiyou.....	248	145	471	276	719	421
Stanislaus.....			950	556	950	556
Trinity.....	18,969	11,097	1,985	1,161	20,954	12,258
Tuolumne.....	302	177	14	8	316	185
Yuba.....	28	16	8,366	4,894	8,394	4,910
Total, 1927.....	1,461,560	855,013	17,211	10,068	1,478,771	865,081
	1,599,339	906,825	20,903	11,852	1,620,242	918,677

Mine production of gold, silver, copper, and lead in California in 1928, by counties—Continued

County	Copper		Lead		Grand total value
	Pounds	Value	Pounds	Value	
Alpine.....			3,000	\$174	\$560
Amador.....	1,400	\$202			2,251,441
Butte.....					49,161
Calaveras.....	132,532	19,085	2,800	162	183,088
Del Norte.....					278
Eldorado.....	1,040	150			122,864
Fresno.....					15,530
Humboldt.....					1,795
Imperial.....	219	32			58
Inyo.....	21,547	3,103	1,744,782	101,197	139,029
Kern.....					191,698
Lassen.....					500
Los Angeles.....					2,207
Madera.....	15,170	2,184			5,908
Mariposa.....					122,767
Merced.....					312
Mono.....					182,422
Nevada.....					2,014,800
Placer.....					72,297
Plumas.....	21,140,975	3,044,300			3,568,068
Riverside.....	12,263	1,766	98,911	5,737	11,246
Sacramento.....					1,559,952
San Bernardino.....	109,885	15,823	38,544	2,236	472,517
San Diego.....					2,684
San Luis Obispo.....					726
Shasta.....	3,055,570	440,002	3,000	174	592,739
Sierra.....					678,468
Siskiyou.....					86,138
Stanislaus.....					196,239
Trinity.....	660,142	95,060			510,012
Tuolumne.....					36,992
Yuba.....					2,309,287
Total, 1927.....	25,150,743	3,621,707	1,891,037	109,680	15,381,783
	27,133,008	3,554,424	2,718,014	171,235	116,831,362

¹ Includes \$516,008, value of 8,062,625 pounds of zinc produced in 1927; no zinc produced in 1928.

MINING INDUSTRY

At the end of 1928 few of the new enterprises exploited during the year were on a permanent producing basis. Mining interests gave attention to quiescent lode properties on the Mother Lode, elsewhere in Amador County and in Nevada County, but not much more than surface work resulted. New interest in gold lode mines in Eldorado County perhaps resulted in more actual return than similar interest elsewhere in the State.

Five counties in California produced metals valued at more than a million and a half dollars in 1928—Plumas, with 85 per cent of its total value derived from copper output; Yuba, with 99 per cent of its total value from placer gold; Amador, with almost 99 per cent from lode gold; Nevada, with 97 per cent from lode gold; and Sacramento, with almost 100 per cent from placer gold.

The record of gold production in California shows a steady decline since 1921, due to the fixed price of gold, increased costs of mining, and increased taxes. The gold-mining industry of California is particularly affected by high taxes and insurance compensation rates, and these are matters of profound concern to the gold-mining interests.

The dredging industry was marked by a new boat in the Natoma field, a new one in the La Grange field, one under construction near

Junction City, Trinity County, the abandonment of the Clear Creek dredge in Shasta County, and the cessation of operations by the Isabel dredge at Jenny Lind, Calaveras County. The total quantity of gravel dug by all dredges in the State in 1928 was 49,142,099 cubic yards (51,327,469 in 1927), indicating an average recovery in gold and silver of 9.03 cents a yard as compared with 10.66 cents in 1927 and 9.53 cents in 1926. The total production of gold by dredges since the beginning of the industry (on the Feather River) has been \$159,964,684, of which the Feather River field has yielded \$33,227,519, the Yuba River field \$62,802,828, and the American River field \$37,639,805.

Legislation favorable for hydraulic mining, long under discussion, was not enacted during 1928⁴, despite the public interest and the hearings before various committees on the subject in 1927.

The output of gold from drift placers increased in 1928, as a result of new activities in Sacramento County, but the yield from this source has not been a large factor in recent years in the total production of gold in the State.

Improved conditions in the copper industry were realized by companies operating copper mines in Plumas and Shasta Counties, and plans were made late in the year for increased facilities for mining in 1929. Lead mining in California was confined chiefly to established properties, and there was not the usual number of small shippers of lead ore in Inyo and San Bernardino Counties recorded in past years. The Ubehebe district had a notable lead production and yielded ore high in lead content. No zinc ore was mined in California during 1928.

Ore treated and gold and silver recovered at gold mills in Mother Lode counties in California in 1928^a

County	Ore treated	Gold and silver recovered in bullion			Concentrates produced ^b	Gold and silver recovered from concentrates			Value of total recovery	
		Gold	Silver	Average value per ton of ore		Gold	Silver	Average value per ton of concentrates	Total	Average value per ton of ore
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>		<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>			
Amador.....	284, 129	80, 655. 61	16, 783	\$5. 90	5, 836	22, 299. 43	6, 413	\$79. 63	\$2, 141, 839	\$7. 54
Calaveras.....	10, 132	3, 898. 77	1, 236	8. 03	967	509. 58	750	11. 35	92, 291	9. 11
Eldorado.....	13, 976	4, 191. 04	814	6. 23	116	315. 92	82	56. 72	93, 691	6. 70
Mariposa.....	9, 869	5, 325. 62	2, 389	11. 30	96	323. 85	311	71. 64	118, 365	11. 99
Tuolumne.....	1, 447	1, 572. 90	251	22. 57	2	5. 32	3	56. 00	32, 774	22. 65
Total, 1927....	319, 553	95, 643. 94	21, 473	6. 23	7, 017	23, 454. 10	7, 559	69. 73	2, 478, 960	7. 76
	302, 007	92, 057. 71	19, 050	6. 34	4, 682	17, 940. 27	5, 144	79. 83	2, 287, 579	7. 57

^a Tailings excluded.

^b Includes only concentrates recovered from gold ore.

⁴ Stewart, James D., Is Agriculture to Continue to Restrict Hydraulic Mining in California: Eng. and Min. Jour., vol. 125, No. 23, 1928, pp. 928-931.

Hydraulic Mining Investigations in California: S. Doc. No. 90, 70th Cong., 1st sess., 1928, pp. 1-31.

Engineering and Mining Journal, vol. 126, No. 5, 1928, p. 163.

ORE CLASSIFICATION

Ore, tailings, etc., sold or treated in California, 1921-1928, with content in terms of recovered metals

DRY GOLD ORE

Year	Ore, tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1921	863, 720	353, 993. 36	108, 603	9, 878	640	
1922	984, 785	430, 809. 45	97, 128	3, 296	1, 981	
1923	789, 026	311, 477. 79	82, 787	192	288	
1924	986, 098	383, 796. 60	155, 869	700	5, 613	
1925	803, 712	359, 390. 88	104, 560	122		
1926	660, 095	306, 451. 20	98, 427	119, 846	3, 991	
1927	576, 976	261, 778. 49	97, 444	706	5, 552	
1928	743, 534	266, 832. 42	85, 521	2, 697	2, 800	

DRY SILVER ORE

Year	Ore, tailings, etc.	Gold	Silver	Copper	Lead	Zinc
1921	38, 846	8, 940. 86	3, 220, 927			
1922	67, 363	5, 092. 94	2, 375, 361	7, 514	215	
1923	136, 633	9, 979. 00	2, 762, 977	4, 950	4, 130	
1924	89, 760	8, 255. 74	2, 295, 683			
1925	82, 913	7, 073. 75	1, 992, 859			
1926	57, 231	4, 069. 57	1, 154, 087	714	679	
1927	42, 146	3, 134. 97	935, 145	18, 301	1, 261	
1928	53, 907	3, 249. 05	920, 617	2, 247	2, 520	

COPPER ORE

Year	Ore, tailings, etc.	Gold	Silver	Copper	Lead	Zinc
1921	306, 134	1, 439. 01	175, 870	11, 599, 540		
1922	447, 200	5, 728. 85	320, 977	21, 845, 111	214	
1923	571, 645	8, 523. 74	360, 345	28, 238, 052		
1924	917, 806	21, 129. 50	876, 293	51, 668, 117		
1925	999, 006	16, 584. 58	704, 506	146, 166, 627		
1926	930, 464	11, 233. 14	397, 174	131, 413, 715	687	
1927	854, 084	16, 556. 80	393, 533	126, 288, 052		
1928	901, 562	16, 677. 34	413, 326	125, 115, 682	3, 000	

LEAD ORE

Year	Ore, tailings, etc.	Gold	Silver	Copper	Lead	Zinc
1921	3, 947	806. 93	82, 267	34, 853	1, 123, 636	
1922	26, 466	1, 451. 81	263, 681	65, 944	6, 305, 832	
1923	38, 304	1, 654. 38	330, 241	66, 881	9, 510, 172	
1924	16, 536	795. 37	188, 098	78, 354	4, 758, 193	
1925	18, 208	2, 277. 62	174, 494	58, 342	6, 364, 985	27, 238
1926	30, 445	1, 027. 29	128, 027	34, 669	6, 740, 354	
1927	14, 066	330. 46	72, 644	13, 841	2, 290, 862	
1928	3, 401	266. 95	39, 443	20, 950	1, 783, 806	

ZINC ORE

Year	Ore, tailings, etc.	Gold	Silver	Copper	Lead	Zinc
1921	2, 953	50. 99	2, 926	99, 133		845, 184
1922	14, 072	529. 48	15, 390	613, 482		3, 012, 950
1923						
1924	9, 000	200. 00	22, 500	360, 000		3, 060, 000
1925	33, 384	180. 02	33, 492	639, 822	4, 072	11, 125, 523
1926	57, 079	950. 99	150, 053	1, 875, 230	6, 695	17, 866, 237
1927	24, 266	335. 68	71, 074	798, 722	1, 780	6, 711, 250
1928						

LEAD-COPPER ORE

Year	Ore, tailings, etc.	Gold	Silver	Copper	Lead	Zinc
1921						
1922	47	9. 95	7, 915	4, 138	4, 294	
1923	83	44. 87	2, 788	7, 684	35, 090	
1924-25						
1926	383	135. 60	5, 022	22, 125	173, 207	
1927	193	69. 08	3, 383	13, 386	121, 867	
1928	137	64. 65	2, 653	9, 167	98, 911	

LEAD-ZINC ORE ²

Year	Ore, tailings, etc.	Gold	Silver	Copper	Lead	Zinc
1925	1, 456	2. 50	25, 926		197, 143	336, 476
1926	25, 162	6. 62	70, 308		1, 167, 900	2, 567, 650
1927	14, 679		26, 116		296, 692	1, 351, 375
1928						

¹ Includes copper from mine water.

² No lead-zinc ore, classified as such, in 1921 to 1924, inclusive.

Ore, tailings, etc., sold or treated in California in 1928, with content in terms of recovered metals

Source	Mines producing	Ore, tailings, etc.		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore and tailings.....	236	743,534	43.67	266,832.42	51.15	85,521	5.78
Dry silver ore.....	15	53,907	3.17	3,249.05	.62	920,617	62.26
Copper ore, tailings, etc.....	17	901,562	52.95	16,677.34	3.20	413,326	27.95
Lead ore.....	18	3,401	.20	266.95	.05	39,443	2.67
Lead-copper ore.....	1	137	.01	64.65	.01	2,653	.18
Total, lode mines.....	¹ 287	1,702,541	100.00	287,090.41	55.03	1,461,560	98.84
Total, placers.....	460			234,649.18	44.97	17,211	1.16
	747	1,702,541	100.00	521,739.59	100.00	1,478,771	100.00
Total, 1927.....	783	² 1,526,410		564,585.50		1,620,242	

Source	Copper		Lead	
	Pounds	Per cent	Pounds	Per cent
Dry gold ore and tailings.....	2,697	0.01	2,800	0.15
Dry silver ore.....	2,247	.01	2,520	.13
Copper ore, tailings, etc.....	³ 25,115,682	99.86	3,000	.16
Lead ore.....	20,950	.08	1,783,806	94.33
Lead-copper ore.....	9,167	.04	98,911	5.23
	³ 25,150,743	100.00	1,891,037	100.00
Total, 1927.....	³ 27,133,008		2,718,014	

¹ A mine producing more than one class of ore is counted but once in arriving at total for all classes.

² Yielded also 8,062,625 pounds of zinc; no zinc produced in 1928.

³ Includes copper from mine water.

Ore, tailings, etc., sold or treated in California in 1928, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, tailings, etc.	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Amador.....	¹ 408,045	107,551.64	24,379	1,400	
Butte.....	1,752	483.79	976		
Calaveras.....	10,132	4,408.35	1,986	132	2,800
Eldorado.....	14,021	4,660.27	998		
Fresno.....	10	15.63	5		
Inyo.....	² 1,011	248.62	182	478	
Kern.....	³ 30,230	8,995.15	8,525		
Lassen.....	37	23.78	14		
Los Angeles.....	260	55.87	19		
Madera.....	215	119.87	38		
Mariposa.....	9,932	5,731.10	3,743		
Mono.....	11	29.22	26		
Nevada.....	219,264	94,587.98	35,215		
Placer.....	2,392	2,062.17	381		
Plumas.....	⁴ 2,149	465.66	116	170	
Riverside.....		2.45	2		
San Bernardino.....	⁵ 4,681	1,353.68	1,966	517	
San Diego.....	428	91.26	19		
Shasta.....	778	631.49	125		
Sierra.....	⁶ 31,796	31,117.42	6,032		
Siskiyou.....	2,127	1,237.19	248		
Trinity.....	⁷ 1,897	723.98	186		
Tuolumne.....	⁸ 1,551	1,662.95	302		
Yuba.....	815	572.90	28		
Total, 1927.....	743,534	266,832.42	85,521	2,697	2,800
	576,976	261,778.49	97,444	706	5,552

¹ Includes 103,967 tons of tailings.

² Includes 801 tons of tailings.

³ Includes 15,000 tons of tailings.

⁴ Includes 5 tons of tailings.

⁵ Includes 500 tons of tailings.

⁶ Includes 200 tons of tailings.

⁷ Includes 1,340 tons of tailings.

⁸ Includes 100 tons of tailings.

Ore, tailings, etc., sold or treated in California in 1928, by counties, with content in terms of recovered metals—Continued

DRY SILVER ORE

County	Ore, tailings, etc.	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Inyo.....	50	2.08	4,248	458	2,106
Kern.....	5	4.30	431	-----	-----
Mono.....	11,292	275.87	301,016	-----	-----
San Bernardino.....	42,560	2,966.80	614,922	1,789	414
Total, 1927.....	53,907	3,249.05	920,617	2,247	2,520
	42,146	3,134.97	935,145	18,301	1,261

COPPER ORE

Calaveras.....	⁹ 622	3.59	152	132,400	-----
Eldorado.....	8	17.00	41	1,040	-----
Imperial.....	4	1.20	2	219	-----
Inyo.....	5	19.00	17	363	-----
Madera.....	110	39.51	201	15,170	-----
Plumas.....	748,839	14,778.20	326,511	21,140,805	-----
Riverside.....	40	38.37	17	3,096	-----
San Bernardino.....	1,040	64.73	843	106,877	-----
Shasta.....	¹⁰ 134,272	969.74	66,759	¹¹ 3,055,570	3,000
Trinity.....	16,622	746.00	18,783	660,142	-----
Total, 1927.....	901,562	16,677.34	413,326	¹¹ 25,115,682	3,000
	854,084	16,556.80	393,533	¹¹ 26,288,052	-----

LEAD ORE

Alpine.....	5	1.13	621	-----	3,000
Inyo.....	3,277	251.84	36,490	20,248	1,742,676
San Bernardino.....	119	13.98	2,332	702	38,130
Total, 1927.....	3,401	266.95	39,443	20,950	1,783,806
	14,066	330.46	72,644	13,841	2,290,862

LEAD-COPPER ORE

Riverside.....	137	64.65	2,653	9,167	98,911
Total, 1927.....	137	64.65	2,653	9,167	98,911
	193	69.08	3,383	13,386	121,867

⁹ Includes 621 tons of tailings.

¹⁰ Includes 150 tons of tailings.

¹¹ Includes copper from mine water.

METALLURGIC INDUSTRY

The quantity of ore treated at gold and silver mills by amalgamation and cyanidation in 1928 was 612,665 short tons, an increase of 6 per cent as compared with 1927. In Amador County the custom cyanide plant of the Amador Metals Reduction Co. treated concentrates and tailings, and the new Amador Reclamation & Development Co. began treating by cyanidation the tailings of the Moore mine. In Nevada County the cyanide plant of the New England Consolidated Mines treated concentrates and custom ores from surrounding mines.

In Kern County the Carwymac (Inc.) finished the installation of its ore reduction plant near Randsburg and treated by cyanidation the tailing of the Yellow Aster mine. The Tropico mill treated ore from the Standard mine as well as that from the Tropico mine.

In 1928 the quantity of ore treated at concentrating mills decreased, as compared with 1927, but that shipped direct to smelters increased.

Miscellaneous materials, classed as tailings, which were treated by cyanidation, leaching, and smelting in 1928 amounted to 121,038 tons, an increase of 46,894 tons over 1927. The yield from tailings and mine water in 1928 was 5,084.30 ounces of gold, 2,805 ounces of silver, and 364,486 pounds of copper.

Metallurgic recovery of metals in California in 1928, by methods of recovery

Method of recovery	Material treated	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Ore amalgamated ¹	598,396	211,478.16	48,902	-----	-----
Ore cyanided.....	14,269	10,549.11	288,249	-----	-----
Concentrates cyanided.....	7,061	31,448.45	9,655	-----	-----
Tailings cyanided.....	116,667	4,897.85	1,143	-----	-----
Ore smelted.....	175,847	3,943.38	172,699	3,644,070	1,880,273
Concentrates smelted:					
Flotation.....	46,229	17,698.57	934,377	21,140,805	-----
Other.....	2,172	6,888.44	4,873	1,382	10,764
Tailings smelted.....	4,371	186.45	1,662	² 364,486	-----
Total, 1927 ³	-----	¹ 287,090.41 ⁴ 282,205.48	¹ 1,461,560 ⁴ 1,599,339	² 25,150,743 ² 27,133,008	1,891,037 2,718,014

¹ Includes gold and silver from "high grade" as follows: 10,104.58 ounces of gold and 2,111 ounces of silver.

² Includes copper from mine water.

³ Flotation concentrates smelted in 1927 yielded 8,062,625 pounds of zinc; no zinc produced in 1928.

⁴ Includes gold and silver from "high grade" as follows: 12,235.36 ounces of gold and 2,440 ounces of silver

Mine production of metals from gold and silver mills in California in 1928, by counties

County	Ore, tailings, etc., treated		Recovered in bullion			
	Ore	Tailings, etc.	Amalgamation		Cyanidation	
			Gold	Silver	Gold	Silver
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Amador.....	284,129	100,367	80,655.61	16,783	4,261.78	998
Butte.....	530	-----	137.65	28	-----	-----
Calaveras.....	10,132	-----	3,898.77	1,236	-----	-----
Eldorado.....	13,976	-----	4,206.13	824	-----	-----
Fresno.....	9	-----	14.14	2	-----	-----
Inyo.....	143	800	56.33	41	139.97	15
Kern.....	14,957	15,000	8,133.48	4,623	527.04	588
Lassen.....	35	-----	22.52	12	-----	-----
Los Angeles.....	260	-----	55.87	19	-----	-----
Madera.....	213	-----	114.99	35	-----	-----
Mariposa.....	9,869	-----	5,340.14	2,390	-----	-----
Mono.....	11,260	-----	25.95	17	255.73	272,562
Nevada.....	219,264	-----	71,285.56	15,584	9,058.55	14,131
Placer.....	2,392	-----	2,062.17	381	-----	-----
Plumas.....	2,129	-----	412.97	95	-----	-----
Riverside.....	-----	-----	2.45	2	-----	-----
San Bernardino.....	3,983	500	334.28	120	649.42	1,074
San Diego.....	428	-----	91.26	19	-----	-----
Shasta.....	778	-----	631.49	125	-----	-----
Sierra.....	31,795	-----	30,725.50	5,913	-----	-----
Siskiyou.....	2,124	-----	902.29	195	-----	-----
Trinity.....	1,897	-----	723.98	186	-----	-----
Tuolumne.....	1,547	-----	1,626.20	268	-----	-----
Yuba.....	815	-----	18.43	4	554.47	24
Total, 1927.....	612,665 578,629	116,667 3,640	¹ 211,478.16 ¹ 210,916.59	¹ 48,902 ¹ 47,831	15,446.96 30,513.22	289,392 148,324

¹ Includes gold and silver from "high grade" as follows: 1928, 10,104.58 ounces of gold and 2,111 ounces of silver; 1927, 12,235.36 ounces of gold and 2,440 ounces of silver.

Mine production of metals from gold and silver mills in California in 1928, by counties—Continued

County	Concentrates and recovered metal				
	Concentrates produced	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Amador.....	5,836	22,299.43	6,413	934	-----
Calaveras.....	967	509.58	750	132	2,800
Eldorado.....	116	315.92	82	-----	-----
Kern.....	4	40.91	20	-----	-----
Mariposa.....	96	323.85	311	-----	-----
Nevada.....	2,076	14,243.87	5,500	-----	-----
Sierra.....	92	300.88	101	-----	-----
Tuolumne.....	2	5.32	3	-----	-----
Total, 1927.....	9,189 5,089	38,039.76 19,604.82	13,180 23,038	1,066	2,800 4,460

Mine production of metals from concentrating mills in California in 1928, by counties

County	Ore to concentrating mills	Concentrates and recovered metal				
		Concentrates produced	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Butte.....	1,200	26	278.94	783	-----	-----
Inyo.....	600	18	18.19	565	316	7,964
Plumas.....	748,839	42,781	14,778.20	326,511	21,140,805	-----
San Bernardino.....	42,352	3,448	2,920.37	607,866	-----	-----
Total, 1927.....	792,991 1,814,639	46,273 56,394	17,995.70 17,132.07	935,725 1,195,871	21,141,121 22,252,531	7,964 1,128,481

¹ Yielded also 8,062,625 pounds of zinc; no zinc produced in 1928.

Mine production of metals from California concentrates in 1928

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Amador.....	5,836	22,299.43	6,413	934	-----
Butte.....	26	278.94	783	-----	-----
Calaveras.....	967	509.58	750	132	2,800
Eldorado.....	116	315.92	82	-----	-----
Inyo.....	18	18.19	565	316	7,964
Kern.....	4	40.91	20	-----	-----
Mariposa.....	96	323.85	311	-----	-----
Nevada.....	2,076	14,243.87	5,500	-----	-----
Plumas.....	42,781	14,778.20	326,511	21,140,805	-----
San Bernardino.....	3,448	2,920.37	607,866	-----	-----
Sierra.....	92	300.88	101	-----	-----
Tuolumne.....	2	5.32	3	-----	-----
Total, 1927.....	55,462 161,483	56,035.46 36,736.89	948,905 1,218,909	21,142,187 22,252,531	10,764 1,132,941

BY KINDS OF CONCENTRATES

		Gold	Silver	Copper	Lead
		<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Dry gold.....	9,215	38,318.70	13,963	1,066	2,800
Dry silver.....	3,448	2,920.37	607,866	-----	-----
Copper.....	42,781	14,778.20	326,511	21,140,805	-----
Lead.....	18	18.19	565	316	7,964
Total.....	55,462	56,035.46	948,905	21,142,187	10,764

¹ Yielded also 8,062,625 pounds of zinc; no zinc produced in 1928.

Mine production of metals from California crude ore shipped to smelters in 1928

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Alpine.....	5	1. 13	621	-----	3, 000
Amador.....	19, 949	160. 96	154	466	-----
Butte.....	22	67. 20	165	-----	-----
Calaveras.....	1	-----	-----	650	-----
Eldorado.....	53	155. 22	133	1, 040	-----
Fresno.....	1	1. 49	3	-----	-----
Imperial.....	4	1. 20	2	219	-----
Inyo.....	2, 800	307. 05	40, 316	21, 231	1, 736, 818
Kern.....	278	298. 02	3, 725	-----	-----
Lassen.....	2	1. 26	2	-----	-----
Madera.....	112	44. 39	204	15, 170	-----
Mariposa.....	63	67. 11	1, 042	-----	-----
Mono.....	43	23. 41	28, 473	-----	-----
Plumas.....	20	52. 69	21	170	-----
Riverside.....	177	103. 02	2, 670	12, 263	98, 911
San Bernardino.....	1, 565	495. 12	11, 003	109, 885	38, 544
Shasta.....	134, 122	960. 74	65, 280	2, 822, 834	3, 000
Sierra.....	1	91. 04	18	-----	-----
Siskiyou.....	3	334. 90	52	-----	-----
Trinity.....	16, 622	746. 00	18, 783	660, 142	-----
Tuolumne.....	4	31. 43	32	-----	-----
Total, 1927.....	173, 847	3, 943. 38	172, 699	3, 644, 070	1, 880, 273
	58, 998	3, 590. 24	164, 078	3, 278, 081	1, 302, 088

BY KINDS OF ORE

Dry gold.....	20, 652	1, 670. 47	5, 795	1, 461	-----
Dry silver.....	305	72. 96	40, 189	2, 417	2, 520
Copper.....	151, 952	1, 886. 54	85, 184	3, 610, 394	3, 000
Lead.....	2, 801	248. 75	38, 878	20, 634	1, 775, 842
Lead-copper.....	137	64. 66	2, 653	9, 164	98, 911
	175, 847	3, 943. 38	172, 699	3, 644, 070	1, 880, 273

REVIEW BY COUNTIES

ALPINE COUNTY

The only production of metals in Alpine County in 1928 came from the Joe Larsen claim in Lexington Canyon, east of the town of Loope. The ore shipped averaged 150 ounces of silver and \$4 in gold to the ton and 35 per cent of lead.

AMADOR COUNTY

The total value of metals produced in Amador County in 1928 was \$2,251,441, an increase of \$317,408 over the value for 1927. Lode gold is the chief metal mined in the county, and in spite of the cessation of mining at the Kennedy mine during the last quarter of the year the lode mines increased their yield 16 per cent. Named in order of output in 1928, the ranking gold mines of the county were the Kennedy, Argonaut, Central Eureka, Plymouth, and Moore, with a notable yield from the tailings of the Argonaut. There were no large placer operations in Amador County; the largest production of placer gold came from working a gravel pit, formerly a dredging ground, in the Lancha Plana district.

Ore and tailings (277,321 tons) from 7 properties in the vicinity of Jackson yielded 71,039.18 ounces of gold and 15,561 ounces of silver. The Argonaut mine was in full operation, and 2,104 feet of develop-

ment work was done. The Kennedy mine was operated until September 7, when a fire destroyed the headframe and plant at the main shaft; the mill continued operations until September 21. Rehabilitation of the property began at once. Mining of the old workings at the Moore mine yielded a substantial profit, and the year closed with the company free from debt. The Argonaut Mining Co. suspended operations at the Plymouth mine at the end of the year. The Central Eureka mine was operated full time and the shaft was sunk an additional 100 feet for development of the 4,800-foot level; the zone between this level and the 4,500-foot level is in fractured, moving ground. The recovery per ton of ore treated was \$8.503, and the average assay value of the tailings was \$0.739; according to the annual report of the Central Eureka Mining Co. the average value of the ore milled was \$9.242, and the extraction was $4\frac{1}{4}$ per cent better than for 1927. John Noce worked the dump of the old Lincoln mine near Sutter Creek and uncovered a ledge on the north end of the Lincoln property. The Yellow Tiger Consolidated Mining Co. operated the Pioneer mine and mill until March.

Some of the properties that were exploited during the year were the Henry near Volcano, Big and Little Spanish mines near Plymouth, and the Drytown Consolidated near Drytown. The Lancha Plana Gold Dredging Co. was building a dredge for its property at the line between Amador and Calaveras Counties.

BUTTE COUNTY

The value of metals produced in Butte County was \$49,161 in 1928 compared with \$143,878 in 1927. The large decrease was due to the falling off in the dredge output. Only one boat was in operation in 1928. There were many small surface workings, the gold from which was sold to the banks at Oroville. The Surcease mine was worked intermittently and made the largest gold lode output.

At the Cohan and Gooday property the Genii Mining Co., at Magalia, did extensive work, which involved driving a tunnel 3,200 feet to intersect the Mammoth channel. The Royal Drift Mining Co. spent the entire year on development work to crosscut its channel.

CALAVERAS COUNTY

Mines in Calaveras County in 1928 produced metals valued at \$183,088, a decrease of \$116,106 as compared with the value in 1927. For the third consecutive year this county has failed to hold its former position among those producing metals valued at more than a million dollars. None of its old copper mines was in actual operation, although a clean-up at the Calaveras property yielded more than 100,000 pounds of copper. The Royal Development Co., near Hodson, was the principal producing gold lode property. Three mines in the Fourth Crossing district, including the Demarest and Pioneer Chief, produced 1,505 tons of ore, yielding 278.59 ounces of gold and 73 ounces of silver. The Rindge property near Mokelumne Hill was closed down during the year, and the Black Wonder mine near Mitchell mill was operated by lessees. Three lode mines in the vicinity of Westpoint yielded 223.42 ounces of gold and 46 ounces of silver from 285 tons of ore treated at gold and silver mills.

The shut-down of the Isabel dredge at Jenny Lind in June brought down the gold output from placer mining in Calaveras County. The Vallecito Mining Co. (Inc.) operated its drift property on Six Mile Creek, midway between Angels Camp and Vallecita, the entire year and was the third largest producer of gold in the county.

The Mateo Mining Co. took over the Penn copper mine, 1 mile from Campo Seco, but was not on a producing basis at the close of the year.

DEL NORTE COUNTY

The Myrtle Creek hydraulic property near Crescent City was the only producer of gold bullion in Del Norte County in 1928. The French Hill Mining & Milling Co. developed its claims near Crescent City in preparation for hydraulic mining.

ELDORADO COUNTY

The value of the production of lode and placer mines in Eldorado County in 1928 was \$122,864, an increase of \$40,227 almost entirely from gold lode operations. The principal producing mines, in order of output, were the Ingraham (gold lode) near Placerville, the Kelsey (gold lode) near Placerville, Sliger (gold lode) near Greenwood, and the Carpender (drift) east of Placerville, from which approximately 3,000 ounces of gold was obtained.

The Continental Mines Corporation (Ltd.) took over the bond and lease on the Argonaut mine, from which a small production was recorded. The property of the Hines-Gilbert Gold Mines Co. was shut down the latter part of the year. Fifteen stamps were added to the mill at the Sliger property, and a milling plant at the Middle End property, 4 miles north of Grizzly Flats, was started.

Production was reported from the Van Hooker lode mine, 1 mile north of Placerville, which was under bond to J. A. Flink, and from the Pyramid mine, 4 miles northwest of Shingle Springs. The Swastika Gold Mining Co. took over the Hinds placer mine, 9 miles southeast of Placerville, the last part of the year and installed a washing plant and sluice boxes. Properties under development were the Woodside and Eureka near Georgetown, the Gun Flint and Mexican near Placerville, the Poverty Point 2 miles north of Placerville, and the Vandalia near Shingle.

FRESNO COUNTY

Gravel pit mining near Friant was the chief source of the gold and silver produced in Fresno County in 1928.

HUMBOLDT COUNTY

The gold produced in Humboldt County in 1928 came chiefly from hydraulic operations in the vicinity of Orleans and the washing of beach sands near Orick.

IMPERIAL COUNTY

Two shipments of copper ore accounted for the value of metals credited to Imperial County in 1928. The Valjean-Imperial Mines (Inc.) installed a 25-ton amalgamation mill at its property 3 miles northeast of Ogilby.

INYO COUNTY

Lead was the chief metal produced in Inyo County in 1928, and its value (\$101,197) was 73 per cent of the total value of all metals produced in the county. The output of lead, however, decreased 417,841 pounds, compared with 1927, and would have decreased still more if it had not been for the operations of lessees on the Butte mine in the Ubehebe district, California, out from Bonnie Claire, Nev.

Tailings at the Radcliff mine in the Ballarat district were worked, and the mine and mill were being put in order for active operation. The litigation between the Cerro Gordo and Estelle companies was adjusted and the Estelle Mines Corporation, with perpetual leasehold rights on the Cerro Gordo holdings, began operations on the La Despresiada ore body. The United States Smelting, Refining & Mining Co. operated the Santa Rosa lead mine, and lessees shipped lead ore from the Oversight, 15 miles south of Shoshone. The Tecopa Consolidated Mining Co., for many years an operator in the Resting Springs district, ceased operations except for some leasing on the property. Lessees on the Slate Range property near Trona made shipments of lead ore. In the latter part of the year the Minerals Extraction Co. (Inc.) planned for the all-flotation treatment of its ore. The Big Silver mine on the east slope of the Inyo Range, about 50 miles from Keeler, was being equipped; the Silver Reef mine, 7 miles southwest of Keeler, was under development; and the Ophir lead-silver mine, northeast of Trona, was idle.

KERN COUNTY

The value of the gold and silver produced in Kern County increased from \$180,032 in 1927 to \$191,698 in 1928; the mines contributing most to this output were the Yellow Aster, King Solomon, Tropic, Standard, and Butte Lode. Seven lode mines and one tailings operation in the Randsburg district yielded gold valued at \$158,640, or 85 per cent of the total lode gold output of the county.

Other gold lode mines in the county, from which production was recorded, were the Amy, 35 miles from Caliente; the Keyes near Isabella; and the Orphan Girl near Randsburg. At the Keyes mine 2,000 feet of the old workings were cleaned out and retimbered; the mill was overhauled for development of the mine below the old workings. Development work was carried on throughout the year at the Glen Olive mine near Bodfish.

A small amount of gold was obtained from several dry-wash operations in the county in 1928.

LASSEN COUNTY

Shipments of bullion from lode mining in the vicinity of Milford and Susanville in Lassen County yielded gold and silver valued at \$500.

LOS ANGELES COUNTY

Gold and silver were the only metals produced in Los Angeles County in 1928 from lode mine operations; these metals, with bullion obtained from gravel pit mining near Azusa, were valued at \$2,207.

The Double Eagle mine near Saugus was developed by an incline shaft, and mill tests were made on the ore.

MADERA COUNTY

The value of the gold, silver, and copper produced in Madera County was \$5,908, an increase of \$1,689 compared with 1927, due in large part to the output of copper for the first time since 1924. Shipments of copper ore were made from the Jessie Bell and Daulton mines. The Minaret Mines Co. was reported actively developing the Lou R. Johnston property, the ore from which is said to carry lead, silver, and copper.

MARIPOSA COUNTY

The production of gold and silver in Mariposa County in 1928 was valued at \$122,767, or \$62,414 less than in 1927.

The Original mine, continuously operated since 1918, was again the largest gold producer. In an article published in the Engineering and Mining Journal, Young⁵ states:

From 1919 to 1927, inclusive, 95,030 tons of ore was mined; 30,738 tons of waste and 88,563 tons of ore milled. Waste elimination between mine and mill totaled about 6,500 tons. Gross production for the period totaled \$1,228,593 and net production \$1,211,933. The latter figure is gross less transportation, refinery, and smelting charges. * * * The ore has ranged in value from \$10.81 to \$19.50 per ton; and the concentrate value has ranged from \$101.15 to \$264.32 per ton. The ore is free milling and concentrates are from one-half of 1 per cent to 1 per cent of the ore.

The Nevada Hills Mining Co. (reorganized) unwatered the Virginia mine near Coulterville, retimbered the main shaft, and cleared the lower levels; some shipments of gold bullion and concentrates were made. At the Feliciana mine some ore was milled during the development of the property. Operations on the Mariposa Grant were confined mostly to the Mariposa Extension property, operated under lease. The Grant is gradually being turned over to agricultural pursuits. The Diltz mine in the Whitlock district was the fourth largest lode gold producer in the county. The Colorado mine was under development by the Belmont Metals Corporation.

Small surface workings in the county yielded more than 100 ounces of gold.

MERCED COUNTY

Mining operations in Merced County were confined to prospectors who sold their gold in small lots to storekeepers.

MONO COUNTY

Gold and silver produced in Mono County in 1928 was valued at \$182,422, an increase of \$156,593 compared with 1927; in 1927 a small production of copper and lead was recorded. All the output came from lode mines, and silver was the principal metal produced.

The mine dumps and surface of the Standard property were under lease, and the installation of a 300-ton milling plant was expected to be completed and ready for operation by April, 1929. Development work was under way at the Bodie-Standard ground, and the Bodie shaft was opened by lessees. The Mono Mining Co. of Nevada carried on underground development work at its Silverado property and operated its 100-ton cyanide mill the entire year.

⁵ Young, G. J., Making a 30-Ton California Gold Mine Pay: Eng. and Min. Jour., vol. 127, No. 2, 1929, pp. 45-48.

NEVADA COUNTY

Nevada County, with its two large gold lode mines in the Grass Valley-Nevada City district, produced gold and silver valued at \$2,014,800 in 1928, or \$139,976 less than in 1927. The yield in gold and silver from placer mining decreased \$9,234 and that from lode mining \$130,742.

Mines in the Grass Valley district—mainly the Empire, Idaho-Maryland, and North Star—produced 214,670 tons of ore, which yielded 86,365.13 ounces of gold and 33,358 ounces of silver. Seven operations in the Nevada City district, the largest of which were the Murchie and the Randolph, produced 3,374 tons of ore, yielding 1,249.33 ounces of gold and 399 ounces of silver. Three drift placers near Nevada City—the Graham Bros., Loyal, and Quaker Hill—yielded 705.19 ounces of gold. The Sunrise in the Quaker Hill district and the You Bet in the You Bet district were other drift placers productive in 1928. Aside from the “high grade,” much bullion of unknown origin was sold in small amounts to buyers. This has been credited to small placer operations, mostly sluicing.

The annual report of the North Star Mines Co. for the year ended December 31, 1928, states:

During the year the production of the North Star mine was \$836,567.54, with outlays for current operation amounting to \$734,831.45. The actual amount spent for development was \$147,891.17 * * *.

The year's output came chiefly from rock mined on and between the 6,900 and 8,600 levels on the so-called X vein, 7,200 and 8,700 levels on the new No. 3 vein, and 6,600 and 8,600 levels on the No. 2 vein. A total of 133,408 tons (including 14,525 tons from development) was delivered to the sorting plant, of which 24,808 tons was discarded as waste, leaving 108,600 tons crushed with an average yield of \$7.70 per ton crushed, at an average cost of \$6.76 for operating and \$1.45 for development, making an aggregate cost of \$8.21 per ton and resulting in a loss of 51 cents per ton. The yield per ton in 1928 was 41 cents less, and the cost per ton 19 cents less, than in the previous year.

Of the total production of the year 78.11 per cent was obtained in the mill by amalgamation, while 21.89 per cent was recovered by cyanidation. It is estimated that the value lost in the tailings was 29 cents per ton crushed.

Development work was carried on throughout the year to the extent of 10,458 feet (drifts 6,637 feet, raises 3,431 feet, crosscuts 225 feet, winze and winze chute 121 feet, and switch 44 feet), 3,583 feet on the X vein, 4,717 feet on the No. 2 vein, and 2,158 feet on the No. 3 vein.

The cyanide mill of the New England Consolidated Mines ⁶ treated concentrates from surrounding mines.

Some of Nevada County's gold properties exploited during the year were the Ancho, Gaston, Golden Center, Mohawk, and Spanish. The Omega hydraulic property was being equipped with a débris dam by the South Yuba Mining & Development Co.

PLACER COUNTY

Mines in Placer County yielded gold and silver valued at \$72,297 in 1928, a decrease of \$25,637 compared with the value in 1927. The Three Queens lode in the Foresthill district, the Beauty lode in the Canada Hill district, the Trixie surface in the Dutch Flat district, and the Hometicket drift in the Last Chance district were the principal producers of gold in the county. In the Iowa Hill district the Gleeson,

⁶ Young, G. J., *The New England Mill*: Eng. and Min. Jour., vol. 126, No. 6, 1928, pp. 213-214.

Star United, and Twenty-One drift placers yielded 143.40 ounces of gold. Placer operations in the Michigan Bluff district yielded 120.14 ounces of gold. At the Rising Sun property near Colfax the old mill was torn down and a new 130-ton mill installed.

PLUMAS COUNTY

Plumas County was the leading metal-producing county in the State, in 1928. The value of its metal output was \$3,568,068, or \$309,686 more than in 1927. The copper yield was 21,140,975 pounds, valued at \$3,044,300, or an increase of 85,571 pounds and \$286,042 compared with 1927. There were also increases in the gold and silver output reflecting the increased output of copper, as the two large copper mines yielded 92 per cent of the total gold and practically all the silver recorded for the county. Not much real placer mining was done in the county, the output coming largely from small sluicing and drifting operations in the vicinity of La Porte and Seneca and along Feather River.

The fourteenth annual report of the Engels Copper Mining Co. states:

Production and metal sales.—During the year 20,039 tons of concentrate were produced, of an average copper content of 27.789 per cent. The ratio of concentration was 17.84 to 1. Copper recovery was 91.58 per cent, which is better than that obtained last year.

METALS PRODUCED AND SOLD, 1928

11,137,234 pounds copper at 14.5580 cents per pound.....	\$1, 621, 361. 93
113,549 ounces silver at 58.137 cents per ounce (less 5 per cent) ..	62, 710. 85
1,767 ounces gold at \$19.00 per ounce.....	33, 578. 45
Gross value of production.....	1, 717, 651. 23

COST OF COPPER PRODUCTION

	Total cost	Cost per pound, cents
Operating cost.....	\$827, 652. 15	7. 4314
Freight and smelting charges..... \$527, 736. 08		
Credit by gold and silver..... 96, 289. 30		
	431, 146. 78	3. 8712
Operating and marketing cost.....	1, 258, 798. 93	11. 3026
Add reserve for depreciation.....	79, 125. 75	. 7105
Add development and exploration amortization.....	425, 959. 14	3. 8246
Total cost of copper production.....	1, 763, 883. 82	15. 8377

Exploration results.—* * * In the course of development work completed during the year, 13,717 feet of drifts and raises were driven. 12,233 feet of diamond drilling and 328 feet of shaft sinking was done.

The report of the Anaconda Copper Mining Co. for the year ended December 31, 1928, states:

Operations at the Walker mine were conducted throughout the year. 486,156 tons of ore were broken. The concentrator made an average recovery of 91.294 per cent. 391,275 tons of ore, averaging 1.443 per cent of copper were treated, from which 22,653.70 tons of concentrates, averaging 22.755 per cent of copper were produced. There were sold to the smelter 22,544.86 tons of ore and concentrates yielding 9,613,856 pounds fine copper, 202,313.62 ounces silver, and 13,011.201 ounces gold.

The Yakima-Mohawk Mining Co. had the Hibernia and Southern Eureka mines (Standart group) under bond the latter part of the year and was installing a 10-stamp mill 400 feet below the Hibernia level.

RIVERSIDE COUNTY

Shipments of lead-copper ore from the Mecca property, of copper ore from the Alice group 6 miles southeast of Vidal, and of dump material from the Good Hope property 5 miles south of Perris comprised the source of metals, valued at \$11,246, credited to Riverside County in 1928.

SACRAMENTO COUNTY

The value of the gold and silver produced in Sacramento County in 1928 was \$1,559,952; the output came chiefly from dredges operating in the Natoma field. Reorganization of the Natomas Co. of California, to be known as the Natomas Co., was announced;⁷ it has been estimated⁸ that the company has 10 years of dredging ground ahead.

SAN BERNARDINO COUNTY

Gold, silver, copper, and lead produced in San Bernardino County were valued at \$472,517 in 1928, or \$90,109 less than in 1927. The yield of silver from lode mines was 620,063 ounces, or 168,513 ounces less than in 1927, and the output of copper and lead also decreased. Dry-wash operations in the Holcomb district yielded a small quantity of placer gold.

Lode operations were scattered throughout the county, the Randsburg district yielding the largest output of silver and gold, Goffs district the largest output of copper, and the Clark Mountain district the largest output of lead. Properties yielding between 200 and 450 ounces of gold were the Sidewinder & Bedford, Gateway group, Santa Fe, Black Hawk, and Bagdad Chase (mill tailings). Properties producing more than 1,000 ounces of silver were the Uranium, Oriental, Lost Loon group, Stonewall, and Sidewinder & Bedford. A letter, dated January 4, 1929, to the stockholders of the California Rand Silver (Inc.) calls attention to the depletion of the Randsburg mine.

The Vontrigger (Run Over Consolidated) mine was operated the entire year; production, however, was mainly from development work. In August the Exchequer Mines Co. took over the mine. In March, the Zenda Gold Mining Co. began operations at the Calico mines 5 miles from Daggett, but made no production during 1928.

SAN DIEGO COUNTY

Lode and placer operations in San Diego County in 1928 yielded gold and silver valued at \$2,684, a decrease of \$8,898 compared with 1927. The Rincon Del Diablo, a patented property, 35 miles north-east of San Diego, was operated under lease, and the Eagle mine, also near San Diego, was active part of the year. The Golden Chariot mine was closed.

⁷ Engineering and Mining Journal, vol. 126, No. 11, 1928, p. 427.

⁸ Engineering and Mining Journal, vol. 127, No. 11, 1929, p. 458.

SAN LUIS OBISPO COUNTY

A small amount of gold bullion was reported from mining operations in San Luis Obispo County in 1928, most of which came from gravel washing on Navajo Creek.

SHASTA COUNTY

The value of the metals produced in Shasta County decreased from \$1,284,556 in 1927 to \$592,739 in 1928, a decrease of nearly 54 per cent compared with 1927. Copper mining in the county did not respond to favorable conditions, and the output in 1928 was 1,469,336 pounds less than in 1927. There was no zinc produced, and the lead output was small.

Six gold lode mines in the French Gulch district produced 766 tons of ore, which yielded 383.61 ounces of gold and 88 ounces of silver. Of this group the three principal ones were the Halcyon, Milkmaid, and Mad Ox. The last two mines were closed the end of the year. The Balaklala and Early Bird mines were both productive, but the Mason Mining Co. ceased operations there the end of May.

The Mountain Copper Co. (Ltd.) shipped sulphide ore from the Iron Mountain mine and cinders to its cementation plant at Martinez, but did not operate its flotation plant. The Greenhorn copper property in the Tower House district was rehabilitated. Several pockets of rich quartz were found on the Banghart property, 6 miles north of Schilling. The Niagara mine was under development, and much drifting was accomplished.

The production of gold by three dredges in Shasta County in 1928 amounted to \$71,014 as compared with \$137,092 from the same number of boats in 1927. The Clear Creek dredge was abandoned; the Horsetown dredge operated the entire year, but the life ahead of this operation is reported very short. The third dredge on Cottonwood Creek operated only a part of the year and was not found adaptable for the saving of the fine gold without remodeling.

SIERRA COUNTY

Sierra County mines in 1928 produced gold and silver valued at \$678,468, of which the lode mines alone yielded \$643,254 in gold. Hydraulic operations along Kanaka Creek yielded nearly 100 ounces of gold and drift placers near Goodyears Bar more than 100 ounces. The Hilda hydraulic near Sierra City was operated a short time.

A recent report⁹ describes the gold-quartz veins of the Alleghany district, which in 1928 produced 93 per cent of the total gold output of the county. The Finney mine near Downieville continued under development. New milling equipment was installed at the Brush Creek mine in the Forest district. Near Sierra City development work at the Young America proved satisfactory to the owner. The Monarch mine was developed the entire year at the 342-foot level, and electrical and increased milling equipment was being installed.

⁹ Ferguson, H. G., and Gannett, R. W., Gold-Quartz Veins of the Alleghany District, Calif.: Am. Inst. Min. and Met. Eng., Tech. Pub. No. 211, Class 1, Mining Geology, No. 24, 1929, pp. 3-40.

SISKIYOU COUNTY

The value of the gold and silver produced in Siskiyou County in 1928 was \$86,138, of which the lode mines yielded \$25,720 and the placers \$60,418. Hydraulic operations in the county contributed \$38,236 in gold and silver. The Summerville near Cecilville, the S. T. S. near Sawyers Bar, the Quartz Hill near Scott Bar, and the Hickox near Somesbar were the principal producing hydraulic properties. The Tony Lund placer near Hornbrook was the largest drift operation in the county in 1928. Much of the placer gold was won by small workings and sold to the bullion buyers. The Klamath, Scott, and Salmon Rivers, Eddy's Gulch, and Nolan Gulch were all localities mentioned as being productive. The Northern Mines Co. was installing a 2-foot dredge to work the stream gravel near Callahan.

Lode mines yielding between 100 and 500 ounces of gold, named in order of output, were the Buzzard Hill near Happy Camp, the Advance near Etna, the Schroeder near Fort Jones, and the Bonanza near Forks of Salmon. A mill was installed at the Bonanza property, which was operated only about three months. Much of the lode gold mined in Siskiyou County consists of high-grade rock or "specimen" ore. Late in the year a British Columbia company took over the Black Bear mining claims at the head of Black Bear Gulch and announced plans for the reopening of the property. No development other than the erection of a 10-stamp mill took place at the Independence mine; this property was involved in litigation proceedings over title.

STANISLAUS COUNTY

The total value of the gold and silver produced in Stanislaus County was \$196,239 in 1928, or \$75,656 more than in 1927. A second boat was put in operation in July by the La Grange Gold Dredging Co. This company is dredging ground along Tuolumne and Merced Rivers. The Atlas Rock Co. continued the recovery of gold at its gravel-washing plant near Oakdale.

TRINITY COUNTY

Trinity County yielded gold, silver, and copper valued at \$510,012 in 1928, a decrease of \$7,928 compared with 1927. Placer mining contributed more than 18,000 ounces of the 19,480.33 ounces of gold produced in 1928. Trinity River, Coffee Creek, New River, Rush Creek, Jennings Gulch, Kingsbury Gulch, and Rich Gulch were localities reported as yielding placer gold. Two dredges were operated along Trinity River. The property of the Lewiston Dredging Co. was sold at the end of the year; the new company planned to continue operations. A clean-up of the old Estabrook dredge netted some gold. The new dredge of the Madrona Dredging Co. has 71 buckets, each having a capacity of 9 cubic feet. The dredge is electrically operated and is nearly ready for working the large area controlled by the company above Junction City.

The Brown Bear in the Deadwood district was productive during development work, and the mill on the property was electrically equipped. Production was recorded from the Five Pines mine near French Gulch, and the L. Layman property near Hayfork was in operation.

British Columbia capital took over the Pat Holland group of mining claims on Coffee Creek near Carrville, and the Nash property was under development with plans for steam shovel, screen, and washing equipment. Much work was done on the Dutton Creek hydraulic property, but no production was made. It is understood that the company holding the options had difficulty late in the year over rights of way and water. The La Grange hydraulic mine, inoperative during the past few years, was being rehabilitated; operation at half capacity is expected for 1929.

TUOLUMNE COUNTY

The value of the metals produced in Tuolumne County has been decreasing for the past five years and in 1928 amounted to only \$36,992, or \$3,519 less than in 1927. Most (\$34,376) of this value was in gold from rich quartz pockets.

In the vicinity of Big Oak Flat high-grade gold quartz was mined by two pocket miners. The Experimental, Hudson, Mountain Lily, and Republic mines in the Columbia district yielded nearly 600 ounces of gold. The Fifty-Five mine was operated a short time early in the year; a fire in February destroyed some of its equipment. The property of the Mark Twain Mining Co. was shut down except for leasing operations; one of these yielded approximately \$10,000 in bullion from a small quantity of ore found in a shaft not more than 50 feet deep. The drift property of the Springfield Tunnel & Development Co. was operated from January to August, inclusive. Except for repairs and development work pending reorganization the Clio mine near Chinese Camp was inoperative.

YUBA COUNTY

Yuba County, second only to Plumas County in total value of metals produced in 1928, yielded \$2,309,287, of which \$2,282,454 was in gold won by dredging. Shortage of water hampered placer mining in the vicinity of North San Juan, but the Star Extension ground on the Middle Fork of Yuba River was worked by sluicing and prepared for hydraulicking during the season of 1929-1930. The Beresford claims were also productive. The Willow Creek dredge was not operated after new management took it over in July, although it was expected that dredging would be resumed. Old tailings in the main bed of Yuba River north of Smartsville were worked by placer miners and yielded approximately 200 ounces of bullion. Operation of the 2-stamp mill at the Red Cross mine resulted in a good yield. The shaft at this property is about 130 feet deep. The Halkyard gravel property near Camptonville was under lease and bond, and drifting for the channel was in progress.

GOLD, SILVER, COPPER, AND LEAD IN OREGON

(MINE REPORT)

By V. C. HEIKES ¹

SUMMARY

The total value of the mine production of gold, silver, copper, and lead in Oregon in 1928 was \$296,446, a decrease of 25 per cent as compared with 1927. The value of the gold decreased 26 per cent, silver 30 per cent, and copper 19 per cent; the value of lead increased 130 per cent as compared with 1927. The output in 1928 came from 41 lode mines and 90 placer mines, as compared with 36 lode mines and 150 placers in 1927.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Cop- per	Lead	Zinc	Year	Silver	Cop- per	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

¹ Helen M. Gaylord, of the Bureau of Mines, prepared the statistics for this report.

Mine production of gold, silver, copper, and lead in Oregon, 1919-1928

Year	Mines producing		Ore and tailings (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919.....	23	55	96, 173	47, 303. 25	\$977, 845	111, 121	\$124, 455
1920.....	20	47	82, 156	49, 221. 08	1, 017, 490	82, 743	90, 190
1921.....	23	84	40, 333	42, 668. 39	882, 034	42, 120	42, 120
1922.....	44	126	27, 522	25, 714. 60	531, 568	151, 812	151, 812
1923.....	55	151	50, 385	24, 091. 14	498, 008	96, 322	78, 984
1924.....	43	71	44, 842	26, 695. 36	551, 842	38, 103	25, 529
1925.....	53	94	27, 483	18, 982. 80	392, 409	32, 793	22, 758
1926.....	49	100	21, 727	13, 243. 10	273, 759	29, 733	18, 553
1927.....	36	150	26, 839	14, 676. 16	303, 383	45, 830	25, 986
1928.....	41	90	12, 676	10, 931. 19	225, 968	30, 924	18, 091

Year	Copper		Lead		Total value
	Pounds	Value	Pounds	Value	
1919.....	2, 214, 815	\$411, 955	-----	-----	\$1, 514, 255
1920.....	2, 355, 276	433, 371	-----	-----	1, 541, 051
1921.....	174, 300	22, 485	-----	-----	946, 639
1922.....	1, 046, 525	141, 281	76, 970	\$4, 233	828, 894
1923.....	1, 283, 476	188, 671	27, 523	1, 927	767, 590
1924.....	768, 395	100, 660	513	41	678, 072
1925.....	106, 325	15, 098	5, 612	488	430, 753
1926.....	296, 454	41, 504	11, 549	924	334, 740
1927.....	488, 260	63, 954	5, 300	334	393, 657
1928.....	358, 463	51, 619	13, 246	768	296, 446

GOLD

The decrease in the output of gold in Oregon in 1928 was due largely to the falling off in the yield from placer mining, although the lode mines also in all counties, except Curry, were less productive. Of the total gold produced in 1928 lode mines yielded 5,100.79 ounces, or 47 per cent, and the placer mines 5,830.40 ounces, or 53 per cent. The ratio in 1927 was 39 and 61 per cent, respectively. The production of gold from lode mines decreased 12 per cent, compared with 1927, and that from placers 34 per cent.

Grant County was again the largest producer of gold; it was followed in order by Jackson, Curry, Josephine, and Baker Counties. Curry County was the leading lode gold-producing county, and was the only county that had a relatively large increase in gold yield. Jackson County was the leading source of placer gold.

The quantity of gold produced by dredges was 20 per cent less than in 1927, that from sluicing or surface placers was 40 per cent less, and that by hydraulicking was 70 per cent less. The output by drift mining was nearly three times that in 1927.

In 1928 dry gold ore and tailings yielded 44 per cent of the total gold; copper ore yielded 2 per cent; and dredges, hydraulic mines, and surface and drift placers 53 per cent.

SILVER

The production of silver in Oregon in 1928 was 30,924 ounces, valued at \$18,091, a decrease of 33 per cent in quantity and 30 per cent in value. Grant was the only county producing silver ore and

was first in rank in silver output. Lode mines yielded 97 per cent and placer mines 3 per cent of the total silver output in 1928; this ratio has been maintained since 1924. The chief silver-producing properties in Oregon in 1928, named in order of output, were the Badger Hill, Buffalo-Monitor, Ben Harrison, Silver Peak, and Homestead Iron Dyke. The silver yield from the Homestead Iron Dyke came from concentrates milled in 1927 but not shipped until 1928.

Of the total silver from lode mines in Oregon in 1928 dry gold ore and tailings yielded 67 per cent, dry silver ore 6 per cent, copper ore 14 per cent, and lead ore 13 per cent.

COPPER

The output of copper in Oregon in 1928 was 358,463 pounds, valued at \$51,619, a decrease of 27 per cent in quantity and 19 per cent in value compared with 1927. Twenty per cent of the copper reported for 1928 came from ores treated in 1927. Five counties contributed to the copper output in 1928; Josephine County was first in rank.

LEAD

The mine production of lead in Oregon in 1928 was 13,246 pounds, valued at \$768, an increase of 7,946 pounds in quantity and \$434 in value compared with 1927. Grant was the only lead-producing county in the State.

Mine production of gold, silver, copper, and lead in Oregon in 1928, by counties

County	Mines producing		Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Fine ounces	Value	Fine ounces	Value
Baker.....	9	17	551.88	\$11,408	1,412	\$826
Coos.....		3	11.36	235	2	1
Curry.....	2	5	1,851.93	38,283	281	164
Douglas.....	3		53.23	1,100	2,567	1,502
Grant.....	5	13	3,960.07	81,862	25,530	14,935
Jackson.....	8	22	2,739.75	56,636	615	360
Josephine.....	10	27	1,643.22	33,968	465	272
Lane.....	2		63.75	1,318	29	17
Malheur.....		3	52.04	1,076	8	5
Marion.....	1				14	8
Wheeler.....	1		3.96	82	1	1
Total, 1927.....	41	90	10,931.19	225,968	30,924	18,091
	36	150	14,676.16	303,333	45,830	25,986

County	Copper		Lead		Total value
	Pounds	Value	Pounds	Value	
Baker.....	71,841	\$10,345			\$22,579
Coos.....					236
Curry.....					38,447
Douglas.....	136,014	19,586			22,188
Grant.....	1,422	205	13,246	\$768	97,770
Jackson.....					56,996
Josephine.....	148,250	21,348			55,588
Lane.....					1,335
Malheur.....					1,081
Marion.....	936	135			143
Wheeler.....					83
Total, 1927.....	358,463	51,619	13,246	768	296,446
	488,200	63,954	5,300	334	393,657

The following table summarizes the metal output of Oregon by districts. The Eastern district covers Baker, Grant, Malheur, and Wheeler Counties and the Western district covers Coos, Curry, Douglas, Jackson, Josephine, Lane, and Marion Counties.

Mine production of gold, silver, copper, and lead in Oregon in 1928, by districts

District	Ore (short tons)	Gold		Silver	
		Fine ounces	Value	Fine ounces	Value
Eastern:					
Lode.....	10, 286	2, 148. 95	\$44, 423	26, 680	\$15, 608
Placer.....		2, 419. 00	50, 005	271	159
	10, 286	4, 567. 95	94, 428	26, 951	15, 767
Western:					
Lode.....	2, 390	2, 951. 84	61, 020	3, 465	2, 027
Placer.....		3, 411. 40	70, 520	508	297
	2, 390	6, 363. 24	131, 540	3, 973	2, 324
	12, 676	10, 931. 19	225, 968	30, 924	18, 091

District	Copper		Lead		Total value
	Pounds	Value	Pounds	Value	
Eastern:					
Lode.....	73, 263	\$10, 550	13, 246	\$768	\$71, 349
Placer.....					50, 164
	73, 263	10, 550	13, 246	768	121, 513
Western:					
Lode.....	285, 200	41, 069			104, 116
Placer.....					70, 817
	285, 200	41, 069			174, 933
	358, 463	51, 619	13, 246	768	296, 446

MINING INDUSTRY

The mining industry of Oregon in 1928 was aided by a producing gold lode mine in Curry County and by a new dredge on Footh Creek in Jackson County. Work was continued on the Llano De Oro hydraulic property, in Josephine County, which has been under reconstruction for a number of years preparatory to large-scale operations.² The Oregon Copper Co. continued development work at its holdings in Baker County and made a small production of copper. Grant was the leading county in total value of metals produced and was the only county producing each of the four metals represented in the State output. Much development work was done in the Sumpter district, and a new dredge was under construction near Sumpter.

² Kellogg, A. E., Development Local Mine Costs \$750,000: Medford (Oreg.) Daily News, April 10, 1928, p. 3.

Ore and tailings sold or treated in Oregon, 1921-1928, with content in terms of recovered metals

DRY GOLD ORE

Year	Ore and tailings	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
1921.....	37,935	19,075.66	36,490	-----	-----
1922.....	6,449	6,189.97	15,250	10,749	1,276
1923.....	29,472	7,506.11	25,515	3,301	857
1924.....	29,855	8,941.37	18,352	1,143	513
1925.....	24,561	9,554.34	20,369	1,205	4,016
1926.....	16,094	6,742.07	22,146	3,043	11,549
1927.....	10,625	4,977.88	36,376	1,720	5,300
1928.....	7,084	4,822.74	20,134	1,103	9,552

DRY SILVER ORE

Year	Ore and tailings	Gold	Silver	Copper	Lead
1921.....	-----	-----	-----	-----	-----
1922.....	3,956	8.76	119,146	23,587	75,694
1923.....	1,973	14.30	46,234	18,221	26,666
1924.....	156	2.20	4,778	2,543	-----
1925.....	182	16.02	9,352	520	1,596
1926.....	1	.29	262	-----	-----
1927.....	-----	-----	-----	-----	-----
1928.....	1,000	11.01	1,908	-----	-----

COPPER ORE

Year	Ore and tailings	Gold	Silver	Copper	Lead
1921.....	2,398	434.02	1,339	174,300	-----
1922.....	17,117	2,771.51	14,405	1,012,189	-----
1923.....	18,940	3,181.98	22,511	1,261,954	-----
1924.....	14,831	2,001.75	12,694	764,709	-----
1925.....	2,740	375.06	1,941	105,600	-----
1926.....	5,632	562.32	6,482	293,411	-----
1927.....	16,214	811.92	8,299	486,480	-----
1928.....	4,577	248.95	4,104	357,041	-----

Ore and tailings sold or treated in Oregon in 1928, with content in terms of recovered metals

Source	Mines producing	Ore and tailings		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore and tailings.....	34	7,084	55.89	4,822.74	44.12	20,134	65.11
Dry silver ore.....	1	1,000	7.89	11.01	.10	1,908	6.17
Copper ore.....	6	4,577	36.11	248.95	2.28	4,104	13.27
Lead ore.....	1	15	.11	18.09	.16	3,999	12.93
Total, lode mines.....	41	12,676	100.00	5,100.79	46.66	30,145	97.48
Total, placers.....	90	-----	-----	5,830.40	53.34	779	2.52
Total, 1927.....	131	12,676	100.00	10,931.19	100.00	30,924	100.00
	186	26,839	-----	14,676.16	-----	45,830	-----

Source	Copper		Lead	
	Pounds	Per cent	Pounds	Per cent
Dry gold ore and tailings.....	1,103	0.31	9,552	72.11
Copper ore.....	357,041	99.60	-----	-----
Lead ore.....	319	.09	3,694	27.89
Total, 1927.....	358,463	100.00	13,246	100.00
	488,200	-----	5,300	-----

¹ A mine producing more than one class of ore is counted but once in arriving at total for all classes.

The following table summarizes the ore output of Oregon by districts. The Eastern district covers Baker, Grant, Malheur, and Wheeler Counties and the Western district covers Coos, Curry, Douglas, Jackson, Josephine, Lane, and Marion Counties.

Ore and tailings sold or treated in Oregon in 1928, by districts, with content in terms of recovered metals

DRY GOLD ORE

District	Ore and tailings	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Eastern.....	6,435	1,967.90	19,482	1,103	9,552
Western.....	649	2,854.84	652	-----	-----
Total, 1927.....	7,084 10,625	4,822.74 4,977.88	20,134 36,376	1,103 1,720	9,552 5,300

COPPER ORE

Eastern.....	2,836	151.95	1,291	71,841	-----
Western.....	1,741	97.00	2,813	285,200	-----
Total, 1927.....	4,577 16,214	248.95 811.92	4,104 8,299	357,041 486,480	-----

METALLURGIC INDUSTRY

Gold and silver mills in Oregon in 1928 treated 27 per cent of the total ore, concentrating mills 59 per cent, and smelters 14 per cent. No ore or concentrates were treated by cyanidation in Oregon in 1928. Fifty-four per cent of the lode gold was recovered by amalgamation, 11 per cent from ore smelted, and 35 per cent from concentrates smelted. Flotation concentrates represented 32 per cent of the total concentrates made.

Of the total lode silver 25 per cent was recovered from ore smelted, 73 per cent from flotation concentrates, and 2 per cent from ore amalgamated.

Eighty per cent of the copper yield in 1928 came from ore smelted and 20 per cent from flotation concentrates.

Of the lead recovered in 1928, 66 per cent was from flotation concentrates and 34 per cent from ore smelted.

Metallurgic recovery of metals in Oregon in 1928, by methods of recovery

Method of recovery	Material treated	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Ore amalgamated.....	3,369	2,767.06	728	-----	-----
Ore smelted.....	1,807	557.59	7,423	287,060	4,494
Concentrates smelted:					
Flotation.....	544	1,654.93	21,964	71,403	8,752
Other.....	5	121.21	30	-----	-----
	-----	5,100.79	30,145	358,463	13,246

The following tables summarize the metal output of Oregon by districts. The Eastern district covers Baker, Grant, Malheur, and Wheeler Counties and the Western district covers Coos, Curry, Douglas, Jackson, Josephine, Lane, and Marion Counties.

Mine production of metals from ore treated at gold and silver (amalgamation) mills in Oregon in 1928, by districts

District	Ore	Recovered in bullion		Concentrates and recovered metal				
		Gold	Silver	Concentrates produced	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Eastern.....	2,725	407.55	169	110	739.97	9,574	1,103	8,752
Western.....	644	2,359.51	559	5	121.21	30	-----	-----
Total, 1927.....	3,369	2,767.06	728	115	861.18	9,604	1,103	8,752
	3,260	1,588.36	301	182	1,377.67	7,427	1,481	5,300

Mine production of metals from concentrating mills in Oregon in 1928, by districts

District	Ore to concentrating mills	Concentrates and recovered metal			
		Concentrates produced	Gold	Silver	Copper
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>
Eastern (Baker and Grant Counties).....	7,500	434	914.96	12,390	70,300
Total, 1927.....	7,500	434	914.96	12,390	70,300
	23,162	1,593	2,239.38	32,059	439,716

Mine production of metals from Oregon concentrates in 1928

BY DISTRICTS

	Concentrates	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Eastern.....	544	1,654.93	21,964	71,403	8,752
Western.....	5	121.21	30	-----	-----
Total, 1927.....	549	1,776.14	21,994	71,403	8,752
	1,775	3,617.05	39,486	441,197	5,300

BY KINDS OF CONCENTRATES

Dry gold.....	302	1,617.18	18,803	1,103	8,752
Dry silver.....	24	11.01	1,908	-----	-----
Copper.....	223	147.95	1,283	70,300	-----
Total, 1927.....	549	1,776.14	21,994	71,403	8,752

Mine production of metals from Oregon crude ore shipped to smelters in 1928

BY DISTRICTS

	Ore	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Eastern.....	61	86.47	4,547	1,860	4,494
Western.....	1,746	471.12	2,876	285,200	-----
Total, 1927.....	1,807	557.59	7,423	287,060	4,494
	292	474.42	4,374	46,973	-----

BY KINDS OF ORE

Dry gold.....	15	438.50	603	-----	800
Copper.....	1,777	101.00	2,821	286,741	-----
Lead.....	15	18.09	3,999	319	3,694
Total, 1927.....	1,807	557.59	7,423	287,060	4,494

REVIEW BY COUNTIES

BAKER COUNTY

The total value of metals produced from 17 placer and 9 lode operations in Baker County in 1928 was \$22,579, or \$128,529 less than in 1927. No mine produced from actual mining in 1928 as much as 100 ounces of gold or 100 ounces of silver. Many of the producing properties were worked only a short time, and the output came from development work. The Superior dredge near Bridgeport was not operated, but new equipment was purchased and operations were expected to be resumed in February, 1929. A new hydraulic dredge was reported being built to operate on gravel ground in the vicinity of Sumpter.³

The quartz property of the United Consolidated group, 12 miles southeast of Medical Springs, was developed "for greater depths." Other properties under development were the Whited and Payton group and the Gleeson near Baker and the Hallock near Durkee. The Oregon Copper Co. did much drifting and crosscutting at its property and made a test shipment of ore. It was reported that the Imperial mine in the Cable Cove district would soon be ready for production. The Connor Creek Extension Mining Co. developed its property near Home.

COOS COUNTY

There was very little placer mining along the beaches of Coos County in 1928; the output of gold from that source was only 11.36 ounces.

CURRY COUNTY

The value of the gold and silver produced in Curry County in 1928 was \$38,447, most of which came from lode operations. The gold output from beach mining, however, also increased over 1927.

An interesting development in Curry County was that of the Robert E. mine; this mine made a large output in 1928 after having been under development for a number of years. It produces ore which assays very high in gold.

Fred Voit developed his lode claim near Agness. Lynch and Boyer were preparing the Fall Creek placer group for ground sluicing. G. F. Sparks and partners prospected the Elk Horn gravel property near Port Orford. The Inman placer near Sixes was under development.

DOUGLAS COUNTY

The value of the metals produced by 3 lode mines in Douglas County in 1928 was \$22,188, or \$21,404 more than was produced by 1 lode and 4 placer operations in 1927. Most of the total metal value in 1928 was in copper, and the copper ore yielded in large part the gold and silver values also. Shortage of water curtailed placer mining in the county.

The principal activity centered about Riddle; in this vicinity are the Banfield and Silver Peak copper mines. The tunnel at the Con-

³ Deuzel, L. E., New Type Gold Dredge Tried in Oregon; Mining Truth, Dec. 3, 1928, pp. 7-8.

tinental mine, 12 miles from Myrtle Creek, was about completed, and some ore from this property was ready for shipment to the smelter.

GRANT COUNTY

Mines in Grant County in 1928 produced metals valued at \$97,770, the largest county yield in the State. This value, however, was \$76,252 less than that in 1927 and represented a decrease in each metal except lead. The Empire dredge, working on alluvial gravel 2 miles west of John Day, made the largest individual output of gold; the Buffalo-Monitor group was second in rank; and the Ben Harrison, from which concentrates were shipped, was third. The Susanville Mines Corporation operated its flotation mill three months and shipped the concentrates containing gold and silver to a smelter. R. B. McGinnis took the La Bellevue group near Granite under option; development work was started. The Morris group, a silver property 15 miles southwest of Granite, was also under development.

JACKSON COUNTY

Jackson County ranked second in value of metals produced in 1928, increasing its production of gold considerably over 1927. A new dredge was installed on Foots Creek; it began operations in the last quarter of the year. The Pacific (Layton) hydraulic in Ferris Gulch, 3 miles northwest of Applegate, was operated on a productive basis from March 20 to August 1 by the Pacific Placer Co., which has held the property for 13 years. Bullion output was recorded from the Federal hydraulic placer on Little Applegate River; this property was taken over by a receiver during the year and was operated only four weeks. There was much small surface placering in the vicinity of Applegate, Jacksonville, and Medford. Development of the White Horse mine near Medford gave good results, and a mill was being installed at the property for operation early in 1929.

JOSEPHINE COUNTY

The value of the gold, silver, and copper produced in Josephine County in 1928 was \$55,588, an increase of \$2,971 over 1927. The output of Josephine County was more indicative of improved conditions than that of Curry, Jackson, or Douglas, which also increased their output, as it represented no new properties with large production in 1928 but rather steady development of old properties. The principal mines contributing to the output were the Robertson, (Progressive), Humdinger, and Cow Boy and Queen of Bronze. The Robertson mine, which has yielded much high-grade ore, was taken over by K. Dean Butler, of Portland, who planned to install a 15-ton mill to replace the 2-ton mill formerly in use; a substantial increase in the production at this property was anticipated for 1929. The Greenback near Leland was developed and lessees on the property made a small recovery of gold. Considerable gold from small lode operations was sold to bullion buyers in Grants Pass. The Dean and Dean hydraulic placer on Rogue River near Galice was again productive; the Oscar Creek hydraulic mine, 4 miles east of Murphy, was operated on a productive basis during January, February, and

March; and S. T. Smith operated the Lone Star hydraulic on Sucker Creek in May and in the fall of 1928. Development work only was carried on at the Llano De Oro hydraulic property in the Waldo district, and some gold and platinum were recovered. This property is equipped with a ditch 25 miles long and with 40,000 feet of pipe and flume. The Almeda mine near Grants Pass was under lease and option to the Wearea Mining Corporation which planned further development of the property. New interests took over the Queen of Bronze property in the Waldo district with a view to installing new equipment.

LANE COUNTY

The production of metals in Lane County in 1928 came from lode mines in the Bohemia district and was valued at \$1,335. Some bullion was recovered from the Musick lode mine near Cottage Grove. The Lucky Boy Mining Co. acquired the property of the Consolidated Lucky Boy Mines Co., 5 miles north from Blue River, and development of this property was pending.

MALHEUR COUNTY

Mining in Malheur County in 1928 was confined to the placers which yielded \$1,081 in gold and silver. The output in 1927 was \$1,237 from placers and \$125 from 1 lode mine. Hydraulic mining in the vicinity of Vale was the chief source of the gold output.

MARION COUNTY

The metals produced in Marion County in 1928 were valued at \$143 and came from a shipment of copper ore from the Lotz-Larsen property east of Salem. This property had not been productive since 1924.

WHEELER COUNTY

One lode mine in Wheeler County produced a few ounces of gold.

TIN¹

By CHARLES WHITE MERRILL,²

GENERAL SUMMARY

Tin is the only common nonferrous metal of which the United States is the world's leading consumer and at the same time a negligible producer. This country produced the equivalent of only about one-twentieth of 1 per cent of the virgin tin it consumed in 1928. The domestic production in 1928 amounted to 42 long tons, valued at \$47,400—36.6 tons from Alaska, 3.6 tons from California, and 1.8 tons from South Dakota. However, the recovery of secondary tin—that is, the reclamation of tin from old tin products—in the United States is of great importance. Nearly one-third of the domestic supply of tin is now annually obtained in this manner.

Summary of statistics for tin in the United States, 1926–1928

	1926	1927	1928
Production.....long tons..	7.14	24	42
Monthly price of Straits tin in New York:			
Highest.....cents per pound..	70.67	69.31	55.64
Lowest.....do.....	60.62	57.63	47.10
Average.....do.....	65.30	64.37	50.46
Imports for consumption.....long tons..	77,159	71,142	77,970
Exports (domestic and foreign).....do.....	1,980	2,239	1,617
Reclaimed tin.....do.....	29,821	32,946	31,964

The world mine production of tin in 1928 amounted to 179,000 long tons, an increase of 12 per cent over the 160,015 tons produced in 1927. The output of the three leading producing countries amounted to 139,944 tons in 1928, or 78 per cent of the world total; the Federated Malay States produced 61,935 tons, or 35 per cent of the world total; Bolivia 41,409 tons, or 23 per cent; and the Netherland East Indies 36,600 tons, or 20 per cent. The smelter production of tin was even more localized than the mine output, as the three leading tin-smelting countries produced 96 per cent of the world total; the Straits Settlements contributed 49 per cent, the United Kingdom 33 per cent, and the Netherland East Indies 14 per cent.

The principal supply to consumers in the United States enters the domestic market as imported refined pig tin, mainly from the Straits Settlements, United Kingdom, the Netherlands, and China. The imports of tin in 1928 were 77,970 long tons, an increase of 10 per cent over the 71,142 tons imported in 1927. The total value of the imports in 1928 was \$86,983,174, a decrease of 14 per cent from the

¹ Work on manuscript completed June, 1929.

² Figures on imports and exports from the United States compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

value of imports in 1927. This decrease in value was the result of a sharp decline (22 per cent) in price, from an average of 64.37 cents per pound for Straits tin in New York in 1927 to 50.46 cents in 1928.

In spite of the decline in price the world's "visible" stocks (in Government warehouses and in transit) continued to grow throughout the year, increasing from 15,733 long tons on December 31, 1927, to 24,563 tons on December 31, 1928. Data concerning the change in stocks held by consumers, merchants, brokers, and others are not available, but it seems probable that there has been no important increase. Persistent rumors indicate an additional accumulation of some 5,000 to 10,000 tons of tin, which has been taken, it is said, from the London market by "the bull group" to be held until the market shows enough strength to reabsorb this amount at current or at higher prices. A minimum of 12,000 tons in "visible" stocks is considered necessary for undisturbed flow of tin from producers to consumers. In 1927 the "visible" stocks were reduced to a quantity less than 3,000 tons above this minimum, thus placing the producers in a very favorable position. In 1928, however, this surplus was increased to more than 12,000 tons, thus giving the consumers a source of supply that allowed them to dominate the market.

In the United States more than one-half of the tin used goes into the manufacture of tin plate andterneplate and into solders, bearing metals, and bronzes, which are largely consumed in motor-vehicle manufacture. The output of these products showed a decided increase in 1928 over 1927, tin plate andterneplate increasing 9 per cent and motor vehicles 28 per cent. The tin-plate industry of Great Britain showed marked improvement under the Anglo-American tin-plate export agreement, which allots 70 per cent of the combined exports of the two countries to the British producers and 30 per cent to the American.

On the first market day (Monday the third) in December, 1928, the National Metal Exchange, New York, began trading in tin. There has not yet been time enough to demonstrate what influence this new exchange will be able to exert in the international tin market.

At the end of 1928 production was increasing in all the larger tin-mining countries of the world, with the possible exception of China. Exploration and development in productive and prospective tin areas throughout the world were continuing. Improvements in methods of mining, milling, and concentrating were being made and introduced, as well as advances in the auxiliaries to production, such as transportation, central power plants, etc. Considering the year as a whole, it is noted that the tin-consuming industries, though requiring larger amounts of tin than ever before, failed to absorb all of the increased production. Developments in new uses for tin apparently failed to cover the decreases occasioned by substitution of cheaper materials in some other uses. As a result the "visible" stocks continued to rise throughout the year in spite of the inducement offered by falling prices to consumers of tin. A. B. Parsons, in an article, *Is 45-cent Tin Likely*, in the *Engineering and Mining Journal* of April 28, 1928, pages 685-689, concludes a review of the world tin situation with the following paragraph:

If it be assumed that the rate of consumption will increase only moderately, if at all, in the next two years; that Bolivia and the Dutch Indies will contribute approximately the same tonnage as recently; and that increased production in

Nigeria will make up for possible declines in the countries producing less important quantities—one confesses that the event may prove some of these assumptions to be wrong—the factor that looms as most important is the rate of production in Malaya. If it increases to the extent that seems assured, 45 cents ought during the next two years to be a good guess for the average price of tin.

In answer to the article from which the above quotation is taken the International Metal Service (London) wrote an article, a summary of which was published in the *Engineering and Mining Journal* of June 23, 1928, pages 1036–1037, concluding with the following paragraph:

And now to discuss the kernel of what we set out to analyze—the probable price trend in the next two years. Mr. Parsons thinks that 45 cents (say, £200 per ton for standard) ought to be a good guess for the average price of tin during the next two years. It is purely a matter for conjecture, and if we have to guess at all, we should be inclined to reckon that the average price of tin in 1928 will be a little over £220. We only put it that low because a calamitous precognition tells us not to doubt the evidence of our senses—of our intuition that the substantial advance in world production we foresee in the last quarter of the year will cause a severe break in prices and possibly for a time provoke market fireworks. As to 1929, probably the majority of producers would be content if the average selling price of tin were to pan out at £200 or a little more. Whatever optimistic views they may hold now respecting the price outlook for tin, we are afraid their imagination will be chastened before Christmas next.

The uses of tin, the highest priced of the common base metals, have been the subject of much study directed toward substitution of the cheaper base metals and of other substances. This search for substitutes will continue to be a factor in the tin situation even with the low prices now current, and expansion of tin consumption to absorb the increasing production must also cover losses in demand due to the substitution of other materials for tin.

DOMESTIC PRODUCTION

Although the United States has never been an important producer of tin, it does not lack producing deposits altogether; nevertheless, careful studies of areas where tin has been produced or where it has been found, particularly during the World War period, indicate that this country can not expect to supply even an appreciable part of its requirements. The following table gives the domestic mine production for the last 10 years.

Tin mined in the United States (including Alaska), 1919–1928, in long tons

[Metallic tin obtainable from concentrates produced in tin mining]

1919	50	1924	6.3
1920	20	1925	12.3
1921	3.6	1926	7.14
1922	1.3	1927	24
1923	1.7	1928	42

Smelter output of metallic tin in the United States, 1919–1928, in long tons

1919	10,925	1923	6,666
1920	15,761	1924	434
1921	10,305	1925–1928	
1922	8,132		

ALASKA

According to the United States Geological Survey, tin ore concentrates produced in Alaska in 1928 contained 36.6 long tons of tin, compared with 23.9 tons in 1927 and 7.14 tons in 1926. The placers near York on the Seward Peninsula, about 100 miles north of Nome,

were the principal producers. More extensive developments are projected for the Hot Springs district, near the junction of the Tanana and Yukon Rivers in central Alaska. Prospecting continued near Big Creek in the Ruby district. The concentrates produced in Alaska are shipped to Seattle whence they are reported to be exported to the smelting plants of the Straits Settlements.

CALIFORNIA

The first recorded discovery of tin in what is now the United States was made in California in 1840 in San Bernardino County, near Colton, about 60 miles due east from Los Angeles. H. E. West, in the Engineering and Mining Journal of July 28, 1928, pages 131-132, states:

No reliable data of the tonnage mined or grade of ore are available. However, a study of old records leads me to make the following estimate: Mined and milled, [short] tons, 10,000; content, black tin, per cent, 3; content, total, tons, 300; dressing loss, tons, 60; recovery, tons, 240. The concentrate was reduced in a furnace, and allowing for loss in slag, hardhead, fumes, and smoke, approximately 100 tons [89 long tons] of pig tin, say, 98 per cent pure, might have been made.

The ore occurs in a number of veins associated with granitic intrusives. The mines had been idle for many years, but a company recently attempted to revive the district and in 1928 produced ore containing 3.6 long tons of tin.

SOUTH DAKOTA

During 1928 South Dakota produced concentrates containing 1.8 long tons of tin, compared with 325 pounds in 1927. The production was derived from lode-tin deposits in the Tinton and Harney Peak areas of the Black Hills. There have been reports of renewed activities in these areas, but as yet production has been negligible.

OTHER STATES

No other tin production was reported in the United States in 1928. There are, however, areas in Virginia, North Carolina, South Carolina, and Texas that have produced small quantities in the past, and tin minerals are known to occur in many other States.

SECONDARY TIN

The recovery of secondary tin in the United States has an important effect on the world tin situation. In 1928 the secondary tin recovered was equivalent to 41 per cent of the virgin tin imported into the United States. The recovery of secondary tin, as metal, in alloys, and in chemical compounds, in the United States during the last 10 years has been as follows:

Secondary tin recovered as metal and in alloys and chemical compounds in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919-----	21, 458	\$29, 868, 200	1924-----	27, 946	\$31, 062, 100
1920-----	20, 982	22, 705, 700	1925-----	27, 634	35, 165, 400
1921-----	15, 089	9, 668, 500	1926-----	29, 821	42, 511, 500
1922-----	17, 420	12, 443, 500	1927-----	32, 946	46, 302, 100
1923-----	26, 973	25, 316, 000	1928-----	31, 964	35, 678, 300

The quantity of secondary tin recovered fluctuates with the price of virgin metal. The main sources from which tin is reclaimed are tin plate and tin alloys.

Most of the tin plate entering the reclaiming processes is composed of trimmings incidental to the fabrication of tin-plate products. A small amount of used tin cans also enters the detinning plants. This latter source, though very large, is not very satisfactory because of the difficulty of collection, the expense of removing objectionable adhering material, and the necessity of sorting out the corroded cans. At present the leading method used for tin recovery from tin plate is the chlorine process, which involves the exposure of clean, dry tin plate to dry chlorine gas. The tin is recovered as the chloride, much of which enters as such into the silk, pigment, and ceramic industries. The tin-free steel scrap residue is well suited for charging into basic open-hearth steel furnaces. Other detinning methods of importance are the electrolytic and the alkali methods.

The other great source of secondary tin is the tin-bearing alloys, solder, babbitt, bronze, white metal, type metal, and foils. In this field the junk dealer plays a very important part in the collection and classification of material for treatment. The tin so recovered re-enters the trade largely as alloys which have been brought to desired specifications by remelting with added virgin metals as required.

IMPORTS AND EXPORTS

METAL AND ORE

The smelting of imported tin concentrates in the United States began in 1916. Tin concentrates were first imported for smelting in the United States in 1915, reached the high point both in quantity and value in 1920, and virtually ceased in 1924. The tin content of concentrates imported since 1924 has ranged from 122 to 303 long tons and was 130 tons in 1928. Inability to obtain clean concentrates to mix with the foul Bolivian concentrates ended the United States tin-smelting industry, at least temporarily. The enormous local market, coupled with the proximity of Bolivia, should allow the United States to build up a large tin-smelting industry if a process for handling foul Bolivian concentrates economically, without admixture of clean ore, could be devised.

The small quantity of concentrates produced in Alaska is shipped to Seattle, whence it is reported to be exported to the Straits Settlements for smelting.

Tin concentrate imported into the United States, 1919-1928

[General imports]

Year	Long tons	Value	Year	Long tons	Value
1919.....	17, 139	\$11, 871, 948	1924.....	1 155	\$71, 094
1920.....	30, 489	18, 795, 162	1925.....	1 191	98, 489
1921.....	13, 696	5, 672, 861	1926.....	1 303	187, 396
1922.....	12, 325	5, 504, 434	1927.....	1 122	79, 089
1923.....	2, 692	2, 169, 055	1928.....	1 130	69, 227

1 Recorded as tin content.

Tin content of tin ore, cassiterite, and black oxide of tin imported into the United States, 1927-28, by countries

[General imports]

Country	1927		1928	
	Long tons	Value	Long tons	Value
Bolivia.....	13	\$6,466	46	\$20,219
Canada.....	103	70,066	84	49,008
Denmark.....	2	1,572		
Germany.....	(1)	5		
Honduras.....	(1)	100		
United Kingdom.....	4	880		
	122	79,089	130	69,227

¹ Less than 1 ton.

Metallic tin imported for consumption in the United States, 1919-1928

Year	Long tons	Value	Year	Long tons	Value
1919.....	40,044	\$50,890,019	1924.....	65,059	\$68,953,193
1920.....	56,067	73,440,872	1925.....	76,646	95,121,111
1921.....	24,197	16,645,719	1926.....	77,159	104,793,396
1922.....	60,193	40,797,986	1927.....	71,142	100,865,205
1923.....	68,934	61,092,354	1928.....	77,970	86,983,174

Metallic tin (bars, pigs, blocks, grains, and granulated) imported into the United States, 1927-28, by countries

[General imports]

Country	1927		1928	
	Long tons	Value	Long tons	Value
Australia.....	670	\$951,646	766	\$845,978
Belgium.....	25	37,087		
Canada.....	25	31,212	17	16,937
China.....			50	60,077
Cuba.....			25	29,839
France.....	15	22,307		
Germany.....	1,306	1,869,956	1,799	2,018,366
Guiana (British).....			25	26,666
Hong Kong.....	1,971	2,787,177	2,174	2,487,924
India (British).....			1,035	1,142,543
Japan.....	25	34,351	100	101,196
Java and Madura.....	263	373,203	338	401,264
Malaya (British) (Straits Settlements).....	45,094	64,025,672	52,291	58,334,442
Netherlands.....	7,755	11,405,379	7,153	8,229,377
Panama.....	25	34,974		
Philippine Islands.....	5	7,236		
United Kingdom.....	13,963	19,285,005	12,197	13,288,565
	71,142	100,865,205	77,970	86,983,174

Metallic tin exported from the United States, 1919-1928, in long tons

Year	Domestic ¹	Foreign ²	Year	Domestic ¹	Foreign ²
1919.....	273	68	1924.....	419	540
1920.....	630	297	1925.....	361	571
1921.....	1,030	363	1926.....	675	1,305
1922.....	804	294	1927.....	1,010	1,229
1923.....	750	296	1928.....	349	1,268

¹ Imported as ore and exported as pigs, bars, etc.

² Imported as pigs, bars, etc., and exported as such.

The quantity of tin (bars, pigs, blocks, grains, and granulated) imported into the United States in 1928 was the largest on record, amounting to 77,970 long tons, compared with 71,142 tons in 1927 and 77,159 tons in 1926. The import value of \$86,983,174 in 1928 was, however, considerably below that in any one of the three immediately preceding years. Of the tin imported in 1928, 67 per cent was from the Straits Settlements, 16 per cent from the United Kingdom, and 9 per cent from the Netherlands.

TIN MANUFACTURES

The imports of tin plate, terneplate, and taggers tin in 1928 amounted to 922 long tons, valued at \$152,608, compared with 1,064 tons, valued at \$191,512, in 1927. Of the total in 1928, 88 per cent (by value) came from the United Kingdom.

Tin plate, terneplate, and taggers tin imported into the United States, 1927-28, by countries and by districts

COUNTRY	1927		1928	
	Long tons	Value	Long tons	Value
Belgium.....			7	\$150
Canada.....	20	\$6,619	39	10,563
France.....			(1)	4
Germany.....	(1)	161	94	6,627
Paraguay.....			4	1,057
United Kingdom.....	1,044	184,732	778	134,207
	1,064	191,512	922	152,608
DISTRICT	1927		1928	
	Long tons	Value	Long tons	Value
Buffalo.....			6	1,662
Los Angeles.....	5	1,448	2	533
Massachusetts.....	30	8,587	12	3,015
Michigan.....	11	2,845		
New Orleans.....	39	12,681		
New York.....			113	14,255
Ohio.....	22	6,371	32	8,287
Oregon.....			10	1,103
Philadelphia.....	71	19,160	80	22,723
Pittsburgh.....	92	28,725	(1)	14
St. Lawrence.....	22	6,454	36	9,770
San Francisco.....	695	81,496	488	53,776
Vermont.....	16	4,995	15	3,794
Washington.....	3	800	1	433
Wisconsin.....	58	17,950	127	33,243
	1,064	191,512	922	152,608

¹ Less than 1 ton.

The exports of tin plate, terneplate, and taggers tin amounted to 249,642 long tons, valued at \$26,345,576, in 1928, compared with 253,888 tons, valued at \$29,062,466, in 1927. The countries receiving the larger part of the exports in 1928 were as follows: Japan, \$6,092,237; Canada, \$5,786,247; China, \$3,032,794; Argentina, \$2,166,411; India, \$1,361,707; Mexico, \$1,224,351; Italy, \$943,094; and Brazil, \$936,030. The value of exports to the countries of South America, with the exception of Peru, showed marked decreases, especially to Argentina. The value of those to the United Kingdom, Japan, and Russia, and to many other countries, also decreased. Largely increased exports to China, Canada, and India helped materially, however, to balance these losses, and the net loss from 1927 was a little less than \$2,720,000, or about 9 per cent.

*Tin plate, terneplate and taggers tin exported from the United States, 1927-28,
by countries and by districts*

COUNTRY	1927		1928	
	Long tons	Value	Long tons	Value
North America:				
Canada.....	41,919	\$5,249,123	48,342	\$5,786,247
Central America—				
Costa Rica.....	12	1,876	77	8,563
Guatemala.....	46	5,832	55	6,383
Honduras.....	1	86	1	205
Nicaragua.....	18	2,352	7	841
Panama.....	139	11,288	7	1,148
Salvador.....	32	4,237	48	6,785
Mexico.....	12,079	1,314,552	13,922	1,224,351
Newfoundland and Labrador.....	146	16,265	154	15,970
West Indies—				
British—				
Jamaica.....	49	5,486	48	5,132
Trinidad and Tobago.....	27	3,082		
Other.....	(¹)	26	7	705
Cuba.....	3,763	408,586	4,073	430,535
Dominican Republic.....	34	5,902	20	2,931
Haiti.....	14	2,083	10	1,335
Netherland.....	355	38,513	399	40,077
South America:				
Argentina.....	33,415	3,606,168	22,460	2,166,411
Bolivia.....	26	2,872		
Brazil.....	9,727	1,026,872	9,993	936,030
Chile.....	5,804	606,949	4,823	497,769
Colombia.....	2,474	280,688	1,905	197,361
Ecuador.....	10	1,068	5	767
Guiana, Netherland (Surinam).....	55	6,573	1	135
Paraguay.....	34	3,681		
Peru.....	4,081	427,447	4,956	431,646
Uruguay.....	5,755	621,397	4,600	429,512
Venezuela.....	894	97,595	309	32,344
Europe:				
Belgium.....	342	36,725	625	58,721
Bulgaria.....	725	79,899	155	17,169
Czechoslovakia.....	29	3,555		
Denmark.....	1,006	109,206	903	82,112
Finland.....	36	3,857	41	3,871
France.....	267	32,155	95	9,949
Germany.....	2	190	11	785
Greece.....	3,121	351,274	2,506	236,562
Italy.....	8,282	996,591	9,169	943,094
Latvia.....			1	68
Lithuania.....			9	838
Netherlands.....	906	98,794	297	27,277
Norway.....	1,508	153,576	1,545	144,642
Portugal.....	147	16,333	117	12,175
Rumania.....	170	19,181	96	9,842
Soviet Russia.....	784	87,794	991	103,281
Spain.....	593	69,341	139	20,185
Sweden.....	761	79,442	1,135	109,600
Switzerland.....	198	21,600	36	3,546
Turkey.....	3,170	353,915		
United Kingdom.....	4,192	494,679	242	25,091
Yugoslavia and Albania.....	107	12,828		
Asia:				
Ceylon.....	49	10,554	73	7,478
China.....	20,066	2,146,024	28,727	3,032,794
East Indies—				
British—				
India.....	8,921	981,931	13,017	1,361,707
Malaya (Straits Settlements).....	2,109	239,362	1,203	126,767
Netherland.....	759	87,541	556	55,369
French Indo-China.....	79	8,601	29	3,100
Hong Kong.....	2,404	313,826	2,412	257,528
Japan (including Chosen).....	54,684	6,538,197	55,988	6,092,237
Java and Madura.....	3,830	462,475	2,572	262,890
Kwantung.....	34	3,547	143	10,255
Palestine.....			17	1,863
Philippine Islands.....	4,068	447,105	5,582	602,077
Soviet Russia.....	1,888	208,475	47	6,102
Syria.....	47	4,545	108	11,187
Turkey.....	498	55,627	1,323	145,407

¹ Less than 1 ton.

Tin plate, terneplate, and taggers tin exported from the United States, 1927-28, by countries and by districts—Continued

	1927		1928	
	Long tons	Value	Long tons	Value
COUNTRY—continued				
Africa:				
British—Union of South Africa.....	1,004	\$112,294	505	\$50,166
Egypt.....	3,593	372,952	2,948	286,022
French—				
Madagascar.....	84	12,431		
Other.....	(1)	60		
Portuguese—				
Mozambique.....			6	448
Other.....			1	120
Oceania (British):				
Australia.....	2,493	281,338		
New Zealand.....	33	4,047	(1)	68
	253,888	29,062,466	249,642	26,345,576
DISTRICT				
Alaska.....			(1)	23
Arizona.....	85	9,778	17	1,991
Buffalo.....	24,246	2,966,446	26,418	3,145,020
Chicago.....	1,887	224,591	1,652	201,564
Dakota.....	4,525	586,492	2,706	332,196
Duluth and Superior.....	853	121,777	249	32,160
El Paso.....	6	978	5	1,253
Florida.....	39	4,090		
Hawaii.....	183	15,564	684	59,320
Los Angeles.....	4	1,092	22	1,925
Maine and New Hampshire.....	44	5,416	527	59,074
Maryland.....	89,098	10,304,636	107,483	11,310,861
Massachusetts.....	5	1,149		
Michigan.....	709	90,323	730	90,284
Mobile.....			100	7,511
Montana and Idaho.....	39	4,950		
New Orleans.....	2,226	237,491	643	54,895
New York.....	108,543	11,874,332	85,120	8,355,159
Ohio.....	7,875	1,044,671	13,882	1,690,807
Oregon.....			50	3,855
Philadelphia.....	8,766	946,053	6,199	660,813
Porto Rico.....	(1)	173		
Rochester.....	(1)	89	1	206
St. Lawrence.....	1,071	108,787	1,145	120,827
San Antonio.....	530	65,061	577	58,658
San Francisco.....	711	108,534	415	42,354
Vermont.....	(1)	93	2	854
Virginia.....			4	518
Washington.....	2,443	339,900	1,011	113,448
	253,888	29,062,466	249,642	26,345,576

¹ Less than 1 ton.

CONSUMPTION

The United States is the world's leading consumer of tin. Supremacy in the canning and motor-vehicle industries is the most important factor in the position of America among tin consumers. The Bureau of Mines has canvassed the domestic tin-consuming industries to ascertain their consumption and stocks of virgin tin in 1927 and 1928.³ The results of this work are presented in the following table and text. As the earlier estimates of the War Industries Board (1917) and the Bureau of Mines (1925)⁴ included secondary tin, they are not comparable with the following figures.

³ Umbau, J. B., Consumption of Primary or Virgin Tin in the United States, 1927: Inf. Circ. 6084, Bureau of Mines, 1928, pp. 1-2. Umbau, J. B., Consumption of Primary or Virgin Tin in the United States, 1928: Inf. Circ. 6165, Bureau of Mines, 1929, 8 pp.

⁴ Furness, J. W., Consumption of Tin in the United States, 1925: Inf. Circ. 6019, Bureau of Mines, 1927, pp. 1-3.

Virgin tin consumed in the United States, 1927-28, by uses

Use	1927		1928	
	Long tons	Per cent of total	Long tons	Per cent of total
Tin plate and terneplate.....	24,525	35.96	27,053	36.92
Solder.....	13,602	19.94	13,483	18.40
Babbitt.....	7,595	11.14	7,851	10.72
Bronze.....	4,664	6.84	4,296	5.86
Foil.....	4,193	6.15	5,055	6.90
Collapsible tubes.....	2,710	3.97	2,878	3.93
Chemicals.....	2,620	3.84	4,246	5.79
Tin oxide.....	1,311	1.92	1,183	1.61
Tinning (brass, copper tubes, sheets, shells, wire, nails).....	2,661	3.90	2,636	3.60
White metal.....	849	1.25	802	1.09
Type metal.....	450	.66	400	.55
Castings.....	1,011	1.48	730	1.00
Other alloys.....	557	.82	629	.86
Miscellaneous.....	1,450	2.13	2,028	2.77
	68,198	100.00	73,270	100.00

The estimating of consumption of virgin tin by calculations based on production, imports, exports, and stocks is not dependable, as stocks held by nonconsuming metal dealers are unknown and not determinable, and failure to account for them might affect the totals greatly. Statistical data regarding the imports, exports, and "visible supply" bearing on this problem may be found in following sections.

The stocks of virgin tin held by consumers amounted to 9,264 long tons at the end of 1927 and were 8,587 tons, or less by 677 tons, at the end of 1928. Based on a 365-day year and a consumption equal to that in 1927, the consumer's stocks on hand at the end of 1927 would have sufficed for 50 days without further purchases. The increased consumption and decreased stocks in 1928 reduced this margin at the end of 1928 to a 43-day supply. The addition of "visible supply" and domestic production to consumer's stocks increases the supplies available on American territory to 10,861 and 11,056 tons at the end of 1927 and 1928, respectively, or a 58-day supply for 1927 and a 55-day supply for 1928. None of these figures include the production or the consumption of secondary tin.

The consumption of secondary tin can not be segregated by various uses to the extent that the consumption of the virgin metal can. Only about one-fourth of the total secondary tin is recovered as metallic tin before reuse, and much of the consumption is of alloys by companies who are unable to report the exact tin content of the tin-bearing secondary materials they consume. The Bureau of Mines inquiry on consumption of tin in 1928 accounted for the use of more than 12,000 tons of secondary metallic tin, chiefly in the manufacture of solder, babbitt, bronze, chemicals, and type metal. The tin-alloy store of the United States can best be represented as a reservoir, containing many metals, into which a stream of virgin tin must constantly flow to replace losses and provide for expansion. The quantity of virgin tin required for the manufacture of the common tin-bearing alloys, including solder, babbitt, bronze, etc., and white metal and type metal amounted to 27,717 long tons in 1927 and 27,461 tons in 1928 out of a total of 68,198 tons in 1927 and 73,270 tons in 1928. The principal use of secondary tin, however, is in the manufacture of such alloys, and most of the tin recovered from alloys and reused

does not pass through the pure metallic state during the process of recovery. The alloy scrap is sorted to remove undesirable elements, is melted and analyzed, and then receives sufficient virgin metals to bring the molten mass to the analysis desired.

Much of the tin requirement of the chemical industries is met by the use of tin oxide, tin chloride, and other chemical compounds made from tin scrap and tin drosses. The chemical industries (exclusive of tin oxide manufacture) required, however, 2,620 long tons of virgin tin in 1927 and 4,246 tons in 1928. The manufacture of tin oxide required 1,311 long tons of virgin tin in 1927 and 1,183 tons in 1928.

The quantity of virgin tin consumed in the foil industry increased from 4,193 long tons in 1927 to 5,055 tons in 1928. The requirements for collapsible tubes also increased, from 2,710 long tons in 1927 to 2,878 tons in 1928.

TIN PLATE AND TERNEPLATE

Manufacturers of tin plate and terneplate, the principal use for virgin tin in the United States, reported increased consumption—from 24,525 long tons in 1927 to 27,053 tons in 1928. These figures represent 36 and 37 per cent of the total consumption of virgin tin in 1927 and 1928, respectively.

Tin plate is made by coating steel sheets with pure tin, and in present practice standard tin plate contains about $1\frac{1}{2}$ per cent of tin by weight. One pound of tin will make 220 square feet of tin plate. Terneplate is similar to tin plate, except that an alloy of lead and tin is substituted for pure tin in the coating. Taggers tin is extra-thin tin plate. The larger part of the tin plate and taggers tin manufactured is used for making tin cans, particularly food containers. Terneplate is largely used for roofing, and some is substituted for tin plate in nonfood-product containers, where the toxic effect of the lead is not deleterious.

In 1928 tin was used in the manufacture of 1,714,990 long tons of tin plate and 124,215 tons of terneplate in the United States, compared with 1,583,383 and 105,066 tons, respectively, in 1927. The exports of tin plate, terneplate, and taggers tin amounted to 249,642 long tons in 1928, a decline from the 253,888 tons exported in 1927. Imports declined from 1,064 long tons in 1927 to 922 tons in 1928. The United States produces nearly twice as much tin plate and terneplate as the United Kingdom but exports only about one-half as much as does that country.

*Tin plate and terneplate produced in the United States, 1919-1928, in long tons*¹

Year	Tin plate	Terneplate	Total	Year	Tin plate	Terneplate	Total
1919-----	1, 074, 624	76, 723	1, 151, 347	1924-----	1, 328, 228	90, 426	1, 418, 654
1920-----	1, 374, 979	70, 566	1, 445, 545	1925-----	1, 544, 007	113, 788	1, 657, 795
1921-----	747, 911	46, 363	794, 274	1926-----	1, 674, 322	107, 984	1, 782, 306
1922-----	1, 208, 772	79, 123	1, 287, 895	1927-----	1, 583, 383	105, 066	1, 688, 449
1923-----	1, 414, 404	92, 458	1, 506, 862	1928-----	1, 714, 990	124, 215	1, 839, 205

¹ From Annual Report of American Iron and Steel Institute.

A large part of the tin-plate industry of the United Kingdom is located in Wales. This industry though badly demoralized by the general strike of 1926 reached normal production again in 1928.

H. C. Bond,⁵ past president of the National Federation of Iron and Steel Manufacturers, has made the following statement with regard to the Welsh tin-plate industry.

There are 438 tinplate mills in South Wales with a capacity of an annual average output of about 900,000 tons of tinplates. Of this it is estimated that some 200,000 tons to 250,000 tons are consumed in the home market * * * [The following table] gives the figures of exports of tinplates from the United Kingdom, the United States, and Germany for the years 1913 and 1922 to 1928.

Tinplate exported from the principal tinplate-producing countries, 1913 and 1922-1928, in long tons

Year	United Kingdom	United States	Germany	Total	Year	United Kingdom	United States	Germany	Total
1913.....	493, 921	58, 918	758	553, 597	1925.....	511, 049	161, 386	10, 032	682, 467
1922.....	448, 831	76, 607	5, 726	531, 164	1926.....	375, 041	250, 737	19, 513	645, 291
1923.....	551, 124	124, 477	5, 059	680, 660	1927.....	472, 029	254, 131	29, 116	755, 276
1924.....	555, 415	160, 997	3, 390	719, 802	1928.....	532, 442	249, 362	34, 242	816, 046

* * * Early in 1928, discussions took place with representatives of the principal tinplate manufacturers in the United States, with a view to removing the keen competition for export business, which was resulting in quite unnecessary cutting of prices in many markets. These conversations resulted in an agreement between tinplate manufacturers in South Wales and tinplate manufacturers in the United States. No price arrangement was made, but the manufacturers of both countries agreed to share the combined exports of the two countries in the following proportions:—United Kingdom, 70 per cent; United States, 30 per cent.

Out of the 438 mills in South Wales all but 23 are parties to this arrangement, which carries with it an obligation to restrict output to a figure which enables Welsh manufacturers to supply their domestic demand and 70 per cent of the combined exports of the United Kingdom and the United States.

Sim and Coventry⁶ in the course of their annual report say:

Speaking generally, the United Kingdom tinplate trade has been the most cheerful section of the steel trade during the year, and, with the galvanized sheet trade, has been the backbone of the local steelworks.

There are indications that revisions of tariffs are being contemplated in several consuming countries with a view to fostering local tinplate industries, but as far as international trade is concerned only the rapidly growing German industry offers serious competition to the Anglo-American export agreement.

AUTOMOBILE MANUFACTURE

The automobile industry consumes almost as much tin as the tin plate and terneplate industry. In 1927 22 per cent (about 16,000 long tons) of the total domestic consumption of virgin tin entered into the manufacture of automobiles and replacement parts, or about 11½ pounds of tin to every new automobile made. The number of automobiles produced was 28 per cent more in 1928 than in 1927, and the first few months of 1929 indicate an even greater production during the year. The chief uses of tin in automobile manufacture are in babbitt for engine bearings, solder for radiators, and bronzes for bearings and bushings.

⁵ Bond, H. C., *Welsh Tin-plate Industry in 1928: Iron and Coal Trades Rev.*, vol. 118, Jan. 25, 1929, pp. 139-140.

⁶ *Mining Journal* (London), vol. 164, Jan. 26, 1929, pp. 62-63.

*Production, registration, and exports of motor vehicles in the United States, 1919-1928*¹

Year	Production			Registration (all classes)	Exports (all classes)
	Passenger cars	Trucks and busses	Total		
1919.....	1,577,716	308,465	1,886,181	7,807,000	82,730
1920.....	1,799,522	311,531	2,111,053	9,471,000	171,644
1921.....	1,452,902	142,402	1,595,304	10,660,000	38,430
1922.....	2,302,923	244,285	2,547,208	12,421,000	78,234
1923.....	3,631,728	388,527	4,020,255	15,264,000	151,894
1924.....	3,203,049	397,869	3,600,918	² 17,748,000	178,732
1925.....	3,760,459	505,245	4,265,704	² 20,078,000	302,931
1926.....	3,808,753	490,049	4,298,802	² 22,133,000	305,420
1927.....	2,946,601	454,725	3,401,326	² 23,254,000	384,195
1928.....	3,826,613	530,771	4,357,384	² 24,611,000	507,110

¹ Commerce Yearbook, vol. 1, 1929, pp. 450, 454, and 459.

² Includes road tractors, not previously reported.

Smaller but increasingly important users of tin and its alloys are the manufacturers of airplanes, motor ships, and stationary Diesel engines. All of these products require tin in their manufacture and for much the same purposes as do automobiles.

SUBSTITUTES

The widespread opinion that the reserves of tin, marketable at about current prices, are very limited has for many years encouraged research for substitutes. The relatively high price of tin in comparison with that of most of the common metals has proved an added incentive to substitution.

Some tin has been displaced by increasing the lead content of the alloy in the manufacture of terneplate and by the substitution of terneplate for tin plate in some cases. The research being carried on to substitute lacquers for tin in the manufacture of tin cans has made little progress because of the difficulty in obtaining an appearance of cleanliness and beauty equal to that of the tin as well as the difficulty in duplicating the purely utilitarian qualities of the tin coating. The greatest savings so far made have been achieved by reducing the thickness of the tin coating on tin plate. The percentage of tin in tin plate has been reduced from 1.65 in 1919 to 1.59 in 1927.⁷

The substitution of cadmium for part of the tin in solder has proved satisfactory in some uses. Each unit of cadmium added has the effect of approximately two units of tin, thus allowing lead to displace part of the tin in the solder. The fact that cadmium is a by-product in electrolytic zinc plants indicates that as electrolytic zinc production increases more cadmium is likely to be placed on the market. Cadmium solders would probably be substituted further for tin solders should this increasing production of cadmium at electrolytic zinc plants depress the cadmium price sufficiently. The recent development of silver solders for use where resistance to high temperatures or vibration is essential, as in certain parts of airplanes and in industrial alcohol stills, is of interest, although the effect of such substitution on the consumption of tin is negligible.

⁷ Mantell, C. L., *Future Possibilities of the Tin-Consuming Industries: Metal Ind.*, vol. 27, January, 1929, pp. 5-7.

Aluminum is being used as a substitute for tin in the manufacture of foils and collapsible tubes. The fields where lead is excluded because of its toxic properties are now being invaded by aluminum. According to a recent article,⁸ the addition of 0.2 per cent of sodium silicate to ordinary soaps has proved a success in overcoming the pitting of aluminum by such soap. This should increase substitution, particularly in shaving-cream containers. Tin foil is also meeting competition for use as a food wrapper; for example, in "cellophane," a transparent cellulose product made from wood pulp.

The further introduction of ball and roller bearings, particularly in railroad rolling stock, has cut into fields once held almost exclusively by babbitt and related bearing metals.

The substitution of rayon for silk tends to lessen the use of tin, as rayon, unlike silk, does not require the use of tin salts in preparation for dyeing and in weighting.

PRICES⁹ AND STOCKS

The break in the tin market that started in April, 1927, continued with only minor recoveries until a low monthly average of 47.10 cents per pound was reached in July, 1928. The 1928 high monthly average of 55.64 cents was for January, the low of 47.10 cents was for July, and the year's average was 50.46 cents, compared with a 1927 high of 69.31 cents for March, a low of 57.63 cents for November, and an average of 64.37 cents for the year. The average price for the year 1928 was thus less by 13.91 cents, or 22 per cent, than the average for 1927.

*Monthly price of Straits tin for prompt delivery in New York, 1926-1928, in cents per pound*¹

	1926			1927			1928		
	High	Low	Average	High	Low	Average	High	Low	Average
January.....	63.50	60.75	62.27	67.62½	64.87½	66.47	57.75	54.25	55.64
February.....	64.50	62.00	63.62	71.00	66.50	69.06	54.50	51.12½	52.49
March.....	66.00	63.00	64.49	70.50	68.00	69.31	53.87½	50.25	52.18
April.....	64.25	62.25	63.38	70.00	66.12½	68.02	53.87½	51.12½	52.36
May.....	64.50	60.50	62.44	68.50	66.62½	67.52	52.50	49.87½	51.54
June.....	62.12½	58.50	60.62	68.25	66.00	67.42	49.75	45.75	47.96
July.....	64.25	61.70	63.07	65.75	63.37½	64.06	49.00	46.00	47.10
August.....	66.25	64.12½	65.28	65.62½	63.50	64.47	48.87½	47.25	48.08
September.....	71.00	65.87½	68.92	63.75	57.87½	61.49	49.75	47.00	48.07
October.....	71.75	68.25	70.31	59.50	57.50	58.50	50.00	48.25	49.01
November.....	72.50	68.00	70.67	59.12½	56.12½	57.63	53.00	49.25	50.85
December.....	71.25	66.50	68.47	59.37½	57.75	58.49	53.25	49.37½	50.21
Year.....	72.50	58.50	65.30	71.00	56.12½	64.37	57.75	45.75	50.46

¹ Metal Statistics, 1929, pp. 351 and 353.

The following table shows tin-plate, pig-tin, and sheet-bar tin price changes since 1919 on the dates listed.

⁸ Churchill, H. V., Notes on Inhibition of the Corrosion of Aluminum by Soap: Am. Inst. Min. and Met. Eng. Tech. Pub. 176, 1929, pp. 244-247.

⁹ Prices used in this discussion refer to Straits tin in New York, as quoted in the American Metal Market and published in Metal Statistics, 1929, pp. 351 and 353.

*Changes in prices for tin plate at Pittsburgh, pig tin at New York, and sheet-bar tin at Pittsburgh, 1919-1928*¹

Date	Tin plate (per base box)	Pig tin (per pound)	Sheet bars (per long ton)	Date	Tin plate (per base box)	Pig tin (per pound)	Sheet bars (per long ton)
1919:		<i>Cents</i>		1923:		<i>Cents</i>	
Mar. 21-----	\$7.00	71.50	\$42.00	Feb. 26-----	\$4.95	44.25	\$40.00
Nov. 15-----	7.00	54.25	42.00	Apr. 26-----	5.50	44.125	45.00
1920: Dec. 2-----	7.00	34.00	47.00	Nov. 1-----	5.50	41.875	42.50
1921:				1924: Nov. 25-----	5.50	54.375	37.00
Apr. 13-----	6.25	29.25	39.00	1925: Nov. 19-----	5.50	63.50	35.00
June 14-----	5.75	29.375	39.00	1926: Nov. 9-----	5.50	71.00	36.00
July 29-----	5.25	26.625	32.00	1927: Nov. 30-----	5.25	58.625	34.00
Nov. 3-----	4.75	28.00	30.00	1928: Nov. 15-----	5.35	50.125	34.00
1922: Nov. 23-----	4.75	36.00	36.50				

¹ Metal Statistics, 1929, p. 159.

The monthly average of the world's "visible supply" of tin has been as follows: 1925, 19,538 long tons; 1926, 15,386 tons; 1927, 14,925 tons; and 1928, 18,392 tons. The reduction in supply progressed steadily from the high yearly average of 24,682 tons for 1922 to the low monthly average of 13,352 tons for August, 1926. From this average there was little change until after April, 1928, when, with the exception of a drop in June, there was a steady increase to the end of the year at an average rate exceeding 1,000 tons per month. The visible supply held in the United States has averaged about 2,500 tons for many years, seldom dropping below 1,500 tons and seldom exceeding 5,000 tons. There were no important fluctuations during 1928.

The so-called invisible stocks of tin are exceedingly difficult to estimate, as they consist largely of stocks held by consuming manufacturing companies and by metal merchants and speculators. A study of the questionnaires forming the basis of the Bureau of Mines study of the tin consumption in 1928 indicates that manufacturing requirements rather than current price of the metal determine the stocks carried by consumers of virgin tin in the United States.

WORLD PRODUCTION AND RESOURCES

World production of tin (tin content of ore), 1924-1928, by countries, in long tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924	1925	1926	1927	1928
Australia-----	3,069	3,016	2,860	3,144	2,900
Belgian Congo-----	994	1,060	1,145	864	1,200
Bolivia ¹ -----	31,610	32,224	30,113	36,707	41,409
China ¹ -----	6,993	8,884	6,509	6,220	7,033
England-Cornwall-----	1,986	2,339	2,327	2,593	2,782
India (British)-----	1,316	1,616	2,484	2,447	2,200
Indo-China-----	(²)	582	551	699	(²)
Japan ⁴ -----	(²)	(²)	537	669	(²)
Malay States:					
Federated ¹ -----	44,043	45,926	45,948	52,180	61,935
Unfederated ¹ -----	2,012	2,146	1,773	2,047	2,435
Netherland East Indies-----	30,563	30,661	31,827	34,034	36,600
Nigeria-----	6,200	6,256	7,417	8,056	9,100
Portugal-----	(²)	559	758	695	(²)
Siam ⁴ -----	7,952	7,862	7,341	7,813	7,900
Union of South Africa-----	1,162	1,147	1,111	1,147	1,257
Other countries ⁶ -----	1,500	800	500	700	700
	139,400	145,078	143,201	160,015	179,000

¹ Exports.

² Less than 500 tons; included under "Other countries."

³ Estimate included in total.

⁴ Smelter product.

⁵ Year ended Mar. 31 of year following that stated.

⁶ Includes countries producing less than 500 tons.

World trade in metallic tin, 1927-28, in long tons ¹

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1927												
Shipments from:												
Straits.....	6,132	4,852	7,627	6,053	6,346	7,607	6,886	6,508	8,161	6,230	7,174	8,238
Australia.....	124	101	112	115	116	114	117	117	114	116	114	115
Banka and Billiton.....	1,193	1,509	1,206	698	2,057	1,418	1,003	701	1,037	1,813	1,657	1,285
China.....	193	102	110	302	127	291	100	32	32	5	11	30
Bolivia ²	1,977	865	3,498	2,834	867	3,741	2,775	2,262	2,751	2,343	2,646	3,342
Nigeria ²	680	747	908	(³)	579	584	546	641	710	332	562	733
	10,299	8,176	13,461	10,002	10,092	13,755	11,427	10,261	12,805	10,839	12,164	13,743
Deliveries to:												
United Kingdom.....	1,670	796	1,098	1,311	1,816	829	1,478	830	1,874	1,615	1,530	1,688
United States of America.....	6,295	5,965	6,545	6,720	6,070	5,735	5,950	6,895	6,110	6,005	5,665	4,535
Continental Europe.....	1,747	1,975	1,898	1,538	1,370	2,625	1,876	2,009	1,589	1,955	2,514	2,461
All others.....	393	512	507	570	409	509	465	509	507	687	560	707
	10,105	9,248	10,048	10,139	9,665	9,698	9,769	10,243	10,080	10,262	10,269	9,391
Visible supply:												
Total—												
Shipments (loadings).....	7,642	6,564	9,055	(³)	8,646	9,430	8,106	7,358	9,244	8,164	8,956	9,668
Afloat.....	2,649	3,695	2,467	(³)	2,826	3,332	4,114	3,191	2,809	2,400	2,180	1,956
Landing.....	2,460	2,139	1,486	(³)	1,165	1,070	1,505	1,321	1,035	2,440	1,618	1,543
In warehouse.....	2,591	1,823	2,433	(³)	2,018	1,806	1,652	2,617	1,995	1,680	1,840	2,566
	15,342	14,221	15,441	13,849	14,655	15,638	15,377	14,487	15,083	14,684	14,594	15,733
By countries—												
United Kingdom—												
Afloat—												
Straits.....	523	350	770	(³)	791	1,225	329	575	645	1,145	1,807	871
Australia.....	80	89	77	(³)	65	86	104	104	57	66	95	88
Netherland East Indies.....	209	415	688	(³)	573	309	62	216	278	821	576	651
China.....	100	100	50	(³)								
Stocks—All others.....	1,127	1,390	2,193	(³)	1,579	1,357	1,198	1,737	1,057	962	1,455	2,536
	2,039	2,344	3,778	2,780	3,008	2,977	1,693	2,632	2,037	2,994	3,933	4,146
United States of America—												
Afloat.....	5,895	6,052	7,260	6,537	6,105	7,205	7,632	6,774	7,556	4,963	4,343	6,869
Stocks and landings.....	3,304	2,484	1,709	1,704	1,604	1,519	1,959	2,201	1,973	3,158	2,003	1,573
	9,199	8,536	8,969	8,241	7,709	8,724	9,591	8,975	9,529	8,121	6,346	8,442
Continental Europe—												
Straits.....	2,344	1,763	2,237	(³)	2,297	2,506	2,809	2,288	2,649	2,275	2,984	2,416
Netherland East Indies.....	1,136	1,490	440	(³)	1,641	1,431	1,282	592	868	1,294	1,331	729
Holland and others.....	624	88	17	(³)			2					
	4,104	3,341	2,694	2,828	3,938	3,937	4,093	2,880	3,517	3,569	4,315	3,145
Total visible supply.....	15,342	14,221	15,441	13,849	14,655	15,638	15,377	14,487	15,083	14,684	14,594	15,733
1928												
Shipments from:												
Straits.....	6,567	8,397	8,005	6,774	7,735	8,516	8,707	9,309	8,310	7,611	9,922	7,961
Australia.....	112	134	121	114	108	111	116	114	113	108	103	105
Banka and Billiton.....	1,055	695	513	1,619	1,573	806	982	1,032	1,717	1,126	1,225	1,650
China.....	293	61	167	17	29	10			116	427	301	680
Bolivia ²	2,736	2,643	3,204	2,115	2,607	2,877	3,722	2,406	2,979	3,450	3,366	3,996
Nigeria ²	689	593	770	625	1,156	590	560	569	660	694	1,048	856
	11,452	12,523	12,780	11,264	13,208	12,910	14,087	13,430	13,895	13,416	15,965	15,248
Deliveries to:												
United Kingdom.....	1,667	1,711	1,859	1,274	873	1,691	1,201	1,415	1,456	1,422	3,235	1,236
United States of America.....	5,415	5,790	7,960	7,010	5,335	6,950	5,545	7,200	6,885	6,475	7,145	7,155
Continental Europe.....	2,108	1,498	1,706	1,494	1,933	1,778	1,912	1,917	1,584	2,101	1,848	1,806
All others.....	586	317	593	839	575	789	1,031	1,800	1,141	149	351	446
	9,776	9,316	12,118	10,617	8,716	11,208	9,689	11,832	11,066	10,147	12,579	10,643

¹ Compiled from monthly issues of Iron and Coal Trades Review except figures for April, 1927, which are taken from various sources.² Calculated metallic tin content of ore and concentrates to the United Kingdom only.³ Data not available.

World trade in metallic tin, 1927-28, in long tons—Continued

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1928—Continued												
Visible supply:												
Total—												
Shipments (loadings).....	7,927	9,287	8,806	8,227	9,394	9,443	9,805	10,402	10,256	9,272	11,451	10,396
Afloat.....	2,014	3,120	2,614	2,855	2,397	2,484	2,340	3,490	2,871	2,283	1,513	3,785
Landing.....	2,595	2,085	1,985	1,600	2,730	1,919	2,505	772	2,290	4,332	3,195	2,179
In warehouse.....	2,708	3,153	2,181	2,319	2,543	2,385	3,372	3,792	4,507	5,020	5,908	8,203
	15,244	17,645	15,586	15,001	17,064	16,231	18,022	18,456	19,924	20,907	22,067	24,563
By countries—												
United Kingdom—												
Afloat—												
Straits.....	936	620	855	305	1,240	840	1,302	1,315	1,105	1,145	2,748	571
Australia.....	67	86	93	56	43	46	98	72	76	56	45	40
Netherland East Indies.....	104	209	70	337	121	42	78	322	541	331	453	365
China.....		25									25	
Stocks—All others.....	2,535	3,240	2,088	1,946	1,565	2,156	2,999	2,846	3,289	4,754	5,500	7,954
	3,642	4,180	3,106	2,644	2,969	3,084	4,477	4,555	5,011	6,286	8,771	8,930
United States of America—												
Afloat.....	6,287	8,311	7,629	7,281	6,574	6,903	6,546	8,653	8,099	6,825	6,493	9,554
Stocks and landings.....	2,768	1,998	2,078	1,973	3,708	2,148	2,878	1,718	3,508	4,598	3,603	2,428
	9,055	10,309	9,707	9,254	10,282	9,051	9,424	10,371	11,607	11,423	10,096	11,982
Continental Europe—												
Straits.....	1,533	2,537	2,330	2,144	2,360	3,191	3,217	2,925	2,113	2,180	2,244	2,105
Netherland East Indies.....	1,014	619	443	959	1,453	905	904	605	1,193	1,018	956	1,546
	2,547	3,156	2,773	3,103	3,813	4,096	4,121	3,530	3,306	3,198	3,200	3,651
Total visible supply.....	15,244	17,645	15,586	15,001	17,064	16,231	18,022	18,456	19,924	20,907	22,067	24,563

Tin shipped into the United States and nationality of bottoms in which shipped, 1927-28, in long tons¹

Country	Flag	1927	1928
Australia.....	United States (U. S. Shipping Board).....	30	-----
	United States (Independent).....	610	425
	British.....	35	307
	Dutch.....	-----	4,001
		675	4,733
		25	-----
Belgium.....	Belgian.....	-----	-----
Canada (Pacific).....	United States (Independent).....	-----	378
	British.....	182	275
		182	653
		38	-----
Chile.....	United States (Independent).....	-----	-----
China.....	United States (U. S. Shipping Board).....	66	-----
	United States (Independent).....	1,407	2,250
	British.....	152	115
	Japanese.....	571	782
	Norwegian.....	-----	25
		2,196	3,172
Colombia.....	British.....	-----	35
Egypt (Mediterranean).....	do.....	40	-----
		-----	-----
England.....	United States (U. S. Shipping Board).....	108	21
	United States (Independent).....	215	450
	British.....	13,409	11,922
		13,732	12,393

¹ Division of Statistics, Bureau of Research, U. S. Shipping Board, Special Report D. S. No. 1241, May 9, 1929. Figures subject to revision.

Tin shipped into the United States and nationality of bottoms in which shipped, 1927-28, in long tons—Continued

Country	Flag	1927	1928
Germany.....	United States (U. S. Shipping Board).....	20	.....
	German.....	1,793	1,935
	Japanese.....	125	.....
	Norwegian.....	.....	10
		1,938	1,945
Japan.....	Japanese.....	.....	10
Java.....	British.....	192	172
	Dutch.....	52	145
	Japanese.....	26	.....
		270	317
Mexico.....	United States (Independent).....	5	.....
Netherlands.....	United States (U. S. Shipping Board).....	163	.....
	Dutch.....	7,345	4,231
		7,508	4,231
Philippine Islands.....	United States (Independent).....	30	113
	British.....	125	.....
		155	113
Scotland.....	do.....	.....	17
Straits Settlements.....	United States (Independent).....	22,255	30,122
	British.....	14,968	22,227
	Dutch.....	1,203	1,178
	Japanese.....	346	200
	Norwegian.....	.....	175
		38,772	53,902
Wales.....	British.....	31	377
	Dutch.....	.....	120
		31	497
Summary.....	United States (U. S. Shipping Board).....	387	21
	United States (Independent).....	24,560	33,738
	Belgian.....	25	.....
	British.....	29,134	35,447
	Dutch.....	8,600	9,675
	German.....	1,793	1,935
	Japanese.....	1,068	992
	Norwegian.....	.....	210
		65,567	82,018

REVIEW BY COUNTRIES

BRITISH MALAYA

The southern part of the Malay Peninsula, which is known as British Malaya, consists of three major political divisions—the Federated Malay States, the Straits Settlements, and the Unfederated Malay States. The Federated Malay States is the world's leading producer of tin ore; the Straits Settlements holds first place in smelter output of tin; and the Unfederated Malay States (taken together) ranked ninth among the tin-ore producers of the world in 1928.

Federated Malay States.—The Federated Malay States continued to increase its output, producing 61,935 long tons of tin in 1928, compared with 52,180 tons in 1927 and 45,948 tons in 1926, and setting a new all-time record for one year's production of tin. The increase in 1928 was largely due to the increased output by dredging. Dredging began in British Malaya in 1912, when the Malayan Tin Co. introduced a bucket dredge. In 1920, 20 dredges were in operation and produced about 15 per cent of the total output for the year.

Since 1920 the number of dredges and their output have increased rapidly, reaching 70 dredges and 12,501 tons in 1927 and 89 dredges and 18,752 tons in 1928.¹⁰

The production from the Chinese-owned mines continued in 1928 at about the 1927 rate, in spite of the fall in price, and no decrease in output is anticipated unless the price falls to lower levels.

*Summary of Federated Malay States mining method statistics, 1924-1928*¹

	1924		1925		1926		1927		1928	
	Long tons	Per cent of total	Long tons	Per cent of total	Long tons	Per cent of total	Long tons	Per cent of total	Long tons	Per cent of total
Production:										
European-owned mines.....	20,480	47	20,000	44	20,216	44	21,234	41	30,348	49
Chinese-owned mines.....	23,563	53	25,926	56	25,731	56	30,945	59	31,587	51
	44,043	100	45,926	100	45,947	100	52,179	100	61,935	100
Dredges.....	9,600	22	9,070	20	9,143	20	12,501	24	18,752	30
Other placer mines.....	32,153	73	34,001	74	33,634	73	36,998	71	39,777	65
Lode mines.....	2,290	5	2,855	6	3,170	7	2,680	5	3,406	5
	44,043	100	45,926	100	45,947	100	52,179	100	61,935	100

NUMBER OF DREDGES AT END OF YEAR

Operating.....	42	42	50	70	89
Under construction.....	10	14	21	21	² 21
On order or proposed.....	10	35	41	23	9

¹ Based on data presented in Federated Malay States Report on the Administration of the Mines Department and on the Mining Industries, Kuala Lumpur, Annual.

² 1 construction suspended.

J. Bagnall, chairman of the Straits Trading Co. (Ltd.), said at the general meeting in Singapore on December 28, 1928:¹¹

The mining industry has had another good half year, though the prices realized were not as high as during the preceding six months * * *. In comparison with 1927 the exports of tin and tin ore will show an increase of just under 20 per cent, mainly due to productions of the new dredges in operation * * * and this section of production [dredges] will show still larger figures for 1929 * * *. Over all, subject to values remaining near their present level, we look for an increase in exports from the Federated Malay States next year of a little under 10 per cent in comparison with those of the year which is now concluding.

So far as our information goes there are working in the Federated Malay States 89 dredges with 29 under construction and 3 on order, a total of 121. With Siam, Burma, and the Unfederated Malay States included, the corresponding figures are 118 working, 43 under construction, and 8 on order, a total of 169.

Bagnall also predicted that the Chinese-owned mines in 1929 will continue to contribute about one-half of the Federated Malay States production if present prices continue relatively unchanged.

The slump in the rubber market that followed the collapse of the agreements under the Stevenson Act and the final repeal of that act has undoubtedly had an important effect on the tin-mining industry on the Malay Peninsula. In recent years rubber culture has been the leading activity of the region, tin mining ranking second. The

¹⁰ Federated Malay States, Report on the Administration of the Mines Department and on the Mining Industries for the year 1928.

¹¹ Mining Journal (London), vol. 164, Feb. 2, 1929, p. 86.

ratio of the value of exports in these industries, either including or excluding reexport, was about 3 to 1 in 1927. The reverses in the rubber industry have aided the tin industry in obtaining capital and in contracting with labor during the latter part of 1928 and probably in 1929. The civil war in China does not seem to have affected the movement of Chinese coolie labor either into or out of British Malaya.

It is interesting to note that the statement of W. R. H. Chappel to the stockholders of Ramboutan Tin Mines (Ltd.), referred to in the chapter of this series for 1927, in which he predicted that the 1929 tin production of the Federated Malay States would be at least 65,000 tons, now appears probable of accomplishment. Other officials, in summing up the activities and future outlook of their respective companies, have in almost all instances expressed optimistic hope rather than reasonable expectation. The production of most companies appears to be approximating and sometimes exceeding former estimates. This has been accomplished in part by improvements in mining and concentrating practice. In dredge practice important improvements have been made in jigging, which is rapidly replacing the older sluicing methods of concentration. The installation of new equipment, particularly dredges, does not appear to have been accomplished within the time estimated or at the cost hoped for, but on the other hand the production from new operations has usually equalled or exceeded the predicted recoveries based on results of drilling.

Straits Settlements.—From the standpoint of mine production this British Crown colony has never been an important factor in the world's supply of tin ore, but in smelter production it leads the world. The needs of its large smelting industry are supplied by imports of tin concentrates from other parts of the Malay Peninsula and from the East Indies. Practically all the metallic tin produced is exported, and in consequence a record of such exports approximates the smelter production of the country. The following table shows the exports of tin from the Straits Settlements and the countries to which they were consigned.

Tin exported from British Malaya, 1926-1928, by destinations, in long tons

Destination	1926	1927	1928	Destination	1926	1927	1928
British possessions.....	3, 819	4, 968	5, 311	United States.....	44, 513	46, 371	56, 984
Countries of Europe.....	14, 189	19, 771	19, 769	Other countries.....	1, 009	1, 289	1, 679
Japan.....	1, 613	1, 922	2, 401				
United Kingdom.....	11, 101	9, 452	12, 908		76, 244	83, 773	99, 052

There are two great smelting companies operating in this colony—the Eastern Smelting Co. (Ltd.) and the Straits Trading Co. (Ltd.). The former conducts its principal operations at Penang and the latter at Pulau Brani, Singapore. The export duty on tin concentrates from the British-controlled sections of the Malay Peninsula to countries outside the British Empire affords these companies a virtual monopoly on Malayan tin smelting, and, in addition to the tin concentrates from British Malaya, they treat large quantities of ore imported from the Netherland East Indies, Siam, and Burma.

Unfederated Malay States.—The Unfederated Malay States—Johore, Kedah, Perlis, Kelantan, and Trengganu—are distinct States governed by their several native rulers but all under the protection

and control of the British Empire. These States produced tin concentrates containing 2,435 long tons of metallic tin in 1928, compared with 2,047 tons in 1927 and 1,773 tons in 1926. Johore and Trengganu are the principal producers, but each of the other States makes some contribution to the total tin output.

BOLIVIA

In 1928 Bolivia continued to be the world's second largest producer and exporter of tin and the leading producer of lode tin. The production of tin in 1928 was 41,409 long tons, an increase of 4,702 tons over the production of 36,707 tons in 1927 and an increase of 11,296 tons over the production of 30,113 tons in 1926. The product from the mines, a concentrate containing about 60 per cent of tin and known in the trade by its native name "barilla," was all exported for treatment abroad. Most of it went to the United Kingdom, and smaller amounts went to Germany, Belgium, the Netherlands, France, and the United States. The following tables show the exports of tin in concentrates from Bolivia in 1928, by months, and the yearly exports, 1926 to 1928, by destinations.

*Tin contained in concentrates exported from Bolivia in 1928, by months, and average grade of concentrates exported*¹

Month	Long tons	Grade of concentrates (per cent of tin)	Month	Long tons	Grade of concentrates (per cent of tin)
January.....	3,594	55.89	August.....	3,410	55.79
February.....	2,533	53.14	September.....	3,645	54.60
March.....	3,368	53.06	October.....	3,335	54.31
April.....	3,518	54.56	November.....	3,766	55.33
May.....	3,672	56.36	December.....	3,708	55.35
June.....	3,173	55.02			
July.....	3,687	56.22		41,409	54.97

¹ Mining Journal (London), Mar. 16, 1929, p. 200.

*Tin concentrates exported from Bolivia, 1926-1928, by countries*¹

Country	1926			1927			1928		
	Concentrates (long tons)	Tin content		Concentrates (long tons)	Tin content		Concentrates (long tons)	Tin content	
		Long tons	Per cent		Long tons	Per cent		Long tons	Per cent
United Kingdom.....	50,834	28,919	56.89	61,952	34,040	54.94	71,275	(2)	(2)
Germany.....	1,826	1,027	56.24	3,190	1,736	54.42	2,187		
Belgium.....				43	17	39.53	1,460		
Netherlands.....							263		
France.....	10	5	57.42				45		
United States.....	46	31	67.39	194	90	46.39	34		
Australia.....	20	12	61.20	30	18	59.68			
Chile.....	57	36	63.16	55	16	29.09			
	52,793	30,030	56.88	65,464	35,917	54.87	75,264	41,409	54.97

¹ Compiled from monthly figures furnished by U. S. Bureau of Foreign and Domestic Commerce. Slight adjustments were made at the end of the year in totals for 1926 and 1927. For adjusted totals see world table on p. 335.

² Figures by countries not available.

³ Mining Journal (London), Mar. 16, 1929, p. 200.

A large part of the Bolivian tin concentrates exported to the United Kingdom is smelted and refined by Williams-Harvey & Co. (Ltd.), of Liverpool, and is marketed under the firm's brand "Mellaneer Tin." This company treats the entire output of Patiño Mines & Enterprises Consolidated (Inc.), the largest tin-producing company in the world.

The Patiño Mines & Enterprises Consolidated (Inc.), a New York corporation, is the result of a consolidation of Simon I. Patiño's many tin-mining and allied interests in Bolivia. The properties are near Llallagua in the Department of Chayanta in the west central part of Bolivia and about 250 miles southeast of La Paz, the capital. All the ore mined is concentrated at Catavi. This concentrating plant has been undergoing complete remodeling which, when finished, will increase its daily capacity to 2,000 metric tons in the near future.¹² The capacity in 1925 was 350 tons and in February, 1929, was 1,500 tons. The yearly production capacity, when all changes and additions are completed, is placed at 24,000 metric tons of tin. In January, 1926, the mine reserves were reported by Yeatman and Berry¹³ to be 1,060,612 metric tons of 4.74 per cent tin ore. The latest data available (January, 1928) placed the reserves at 1,231,091 metric tons of 4.74 per cent tin ore and 2,250,000 metric tons of 2.33 per cent tailings.

The following table gives the milling results for the last four years.

Milling results at the Catavi concentrator, Patiño Mines & Enterprises Consolidated (Inc.), 1925-1928

Year	Ore treated (long tons)	Concentrates produced		
		Long tons	Average assay (per cent of tin)	Tin content (long tons)
1925.....	163, 225	15, 827	64. 42	10, 039
1926.....	232, 775	16, 667	59. 22	9, 870
1927.....	299, 858	19, 002	64. 69	12, 182
1928 (Jan.-Sept. 30).....	(¹)	(¹)	(¹)	12, 438

¹ Figures not yet available.

Among the smaller companies operating in Bolivia, the Compagnie Aramayo de Mines en Bolivie, a Swiss corporation, is of special interest because of an agreement concluded with the firm of Guggenheim Bros., of New York, by which the latter company assumed the technical management of the former; the commission charged for this service is 12½ per cent of the operating profit. The Aramayo company produced at its mines from 1926 to 1928 the following quantities of 57 to 60 per cent tin concentrates: 1926, 3,313 metric tons; 1927, 4,045 tons; and 1928, 4,176 tons (approximate).

The remodeling of the Patiño mill and the Aramayo-Guggenheim agreement are high lights in the Bolivian tin industry.

¹² Handy, R. S., Patiño Mines and Enterprises in Bolivia: Min. and Met., vol. 10, February, 1929, pp. 60-64.

¹³ Mining Journal (London), vol. 164, Jan. 26, 1929, pp. 36-38.

NETHERLAND EAST INDIES

The tin-producing areas of the Netherland East Indies are on the small islands of Singkep, Billiton, and Banka and on the northeast shore of Sumatra. This chain of islands is geologically a continuation of the range of mountains that forms the backbone of the Malay Peninsula and in which the tin deposits of the peninsula occur.

The production of tin in the Netherland East Indies was 36,600 long tons in 1928, compared with 34,034 tons in 1927 and 31,827 tons in 1926.

The following table gives the production of the Netherland East Indies from 1925 to 1927.

*Tin content of tin ores produced in the Netherland East Indies, 1925-1927, in long tons*¹

District	Operator	1925 ²	1926	1927
Banka	Government	20,446	19,828	21,509
Billiton	Billiton Co.	9,545	10,940	11,443
Singkep Island	Singkep Tin Co.	667	998	954
Singkep Sea dredging				
Sumatra	Stannum Co.	3	61	128
		30,661	31,827	34,034

¹ Jaarboek van het Mijnwezen in Nederlandsch-Indië Jaarg. 56. Weltevreden, 1929.

² Figures cover period, as follows: Banka, Mar. 1, 1925, to Feb. 28, 1926; Billiton, Jan. 1, 1925, to May 31, 1926; Singkep, July 1, 1924, to June 30, 1925.

There are, and have been for many years, but three large operators in the Netherland East Indies—the Dutch Government, the Billiton Co., and the Singkep Tin Co.

The Government areas are on the Island of Banka and supply approximately 60 per cent of the total production of the country. The tin is won largely from alluvial deposits worked by open-pit methods. Most of the work is done by Chinese coolies either under contract or under the direct supervision of Government agents.

The Billiton Co. has held a tin-mining concession on the Island of Billiton since 1852 and is the only important producer on the island. The company obtains the larger part of its production from alluvial deposits. Unlike the Government areas of Banka, however, there is an important production from tin-bearing lodes on Billiton. The company pays the Government a royalty of five-eighths of the profits made in alluvial mining.

The Singkep Tin Co. operates under a concession granted in 1899. This company operates alluvial and lode mines on Singkep Island and in addition recovers some tin by dredging the sea bottom near the island.

The tin concentrates of the Netherland East Indies are smelted partly within the country and partly in the Straits Settlements. Completion of a smelter in Holland in the near future may materially alter the flow of concentrates from the Netherland East Indies.

NIGERIA

Nigeria exported tin concentrates containing 9,100 long tons of tin in 1928, compared with 8,056 tons in 1927 and 7,417 tons in 1926. Most of the production was derived from the alluvial deposits of the

Bauchi Plateau, in the northeastern part of the country several hundred miles from the Atlantic coast.

The British Colony and Protectorate of Nigeria is undergoing rapid development which is taking the form of road and city building and provision of electric power. Railroad and motor transportation is being substituted for carrier, pack animal, and river barge methods. As the tin fields lie more than 500 miles from ocean shipping points the development of competing transportation systems is of great importance to the tin-mining industry. In addition to the stimulation that improved transportation should afford it is said that the Government is seriously contemplating a revision of the mining laws which would require the holders of mineral concessions to make large expenditures for prospecting and development in areas now held for speculative purposes. In several areas deeper drilling has revealed high-grade tin-bearing gravels underlying a false "bed rock."

From the standpoint of world production, the companies of Nigeria are for the most part very small. The Anglo-Oriental, operating through the Associated Tin Co., is carrying on a consolidation and development program which is rapidly giving the company a dominant position in Nigeria and an important place among the tin producers of the world. Statements in the annual reports of many of the operating companies lack the optimistic tone noted in the reports of Malayan companies. There appears to be a feeling in this area that price fixing in the neighborhood of £250 per ton, even with its attendant risks of overproduction, would benefit the industry.

SIAM

Siam continued to produce at about the same rate as in 1927; the output was 7,900 long tons in 1928, compared with 7,813 tons in 1927 and 7,341 tons in 1926. The tin deposits are in the part of Siam that occupies a portion of the Malay Peninsula; they are found on both sides of the mountain range that forms the backbone of the peninsula. At present the most productive areas are on the western side of the range and include, among others, the Puket Island and Tongkah Harbor districts. It is interesting to note that the proportion produced by dredging operations has increased at the same time that the price of tin has fallen. Except for concentrates treated by a few native smelters supplying local markets, all the concentrates are shipped to the great smelting centers of the Straits Settlements for treatment.

CHINA

The shipments from China in 1928 are reported as 7,033 long tons of tin, somewhat below the average of 8,000 tons per year which prevailed for many years before 1926. The unsettled political condition of the country since the nationalist revolt and the accompanying banditry seem to have had little effect upon the shipments. The bulk of the production comes from the area extending from the Kotchiu district near Mengtze in the southeastern part of Yunnan into the adjacent Provinces of Kwantung and Kwangsi and into northern French Indo-China. The production was originally attributed to alluvial deposits, but closer examination has shown that the tin occurs in well-defined veins in a country rock of limestone and

granite. Originally the deeply oxidized outcrops were worked as alluvial deposits; at present the deeper mines have a vertical depth of more than 1,000 feet. The work is carried on by rather primitive methods, and the output is limited to a great extent by the inadequacy of the supply of water for concentration. The output is smelted in native furnaces using charcoal.

UNITED KINGDOM

The production of tin (content of domestic ores) in the United Kingdom was 2,782 long tons in 1928, compared with 2,593 tons in 1927 and 2,327 tons in 1926. The entire output came from Cornwall, a century ago the leading tin-producing region of the world. The production comes largely from mines with long histories, some dating back to the Roman period. During 1928 several old mines were reopened, and preparations were made to rework the tailings now in dumps, in river beds, and even in harbors to which rivers have carried them from the inefficient mills of former times.

The importance of the United Kingdom in tin production is not based upon the ore output of the mines of Cornwall but rather upon the tin output of the smelters of Liverpool in Lancaster and Redruth in Cornwall. The combined capacity of these smelting plants is approximately 60,000 tons of tin per year, or 39 per cent of the world's annual smelter output. In addition, the new Penpoll smelter, which began operations July 13, 1928, has a rated capacity of 12,000 tons of concentrates per year. The site of this new smelter will allow for expansion to an ultimate capacity of 72,000 tons of concentrates per year, and the operators hope to attain such capacity in the future.

OTHER COUNTRIES

The countries separately discussed accounted for an output of about 169,000 tons of tin, or 94 per cent of the 1928 world total. Australia, India, and the Union of South Africa supplied over half of the remaining 10,000 tons.

Operators of the Mount Bischoff mine, the greatest tin mine in Australia, have finally ceased underground operations and are now confining their attention to the alluvial holdings. According to the Australian Development and Migration Commission, in the Blue Tier tin field near Lottah, northeastern Tasmania, are immense bodies of granite carrying about 0.2 per cent of recoverable tin. A plan of exploitation somewhat similar to the open-pit porphyry copper operations in the United States is being considered; if successful, this plan will mark a new departure in tin-mining methods.

The tin output of the British Indian Province of Burma is derived largely from alluvial deposits near Tavoy, a sea coast town in southern Burma. These deposits are a northern continuation of the Malay Peninsula tin-bearing region.

In addition to Nigeria, Africa has several minor tin-producing districts and several areas which give promise of future production. The Union of South Africa and the Belgian Congo are now the chief of such districts. Much prospecting for and some development of tin deposits is being carried on in Tanganyika, Uganda, South West Africa, Swaziland, Gold Coast, French Morocco, Portuguese East Africa, and Rhodesia.

Among the other countries producing small amounts of tin in 1928 or developing tin deposits are Portugal, Spain, Japan, French Indo-China, Canada, Mexico, Russia, Germany, Czechoslovakia, Argentina, and France.

WORLD'S TIN SMELTERS

Name, location, control, and capacity of the world's tin smelters in 1928

Smelter	Location	Control	Capacity (long tons) ¹
Straits Trading Co.....	Singapore and Butterworth, Straits Settlements.	British.....	65,000
Williams-Harvey.....	Liverpool, England.....	Bolivian.....	45,000
Eastern Smelting Co.....	Penang, Straits Settlements.....	British.....	25,000
.....	Netherland East Indies.....	Dutch.....	25,000
.....	Redruth, Cornwall.....	British.....	15,000
.....	.....	German and others.....	8,000

¹ Annual production of pig tin as reported in Mining Magazine (London), vol. 39, August, 1928, p. 86.

LEAD AND ZINC PIGMENTS AND SALTS

By ELMER W. PEHRSON ¹

SUMMARY

The value of lead and zinc pigments and zinc salts sold by producers in 1928 amounted to \$98,000,000, or 1 per cent less than 1927. Lead pigments accounted for 54.5 per cent of the total value, zinc pigments 43.5 per cent, and zinc salts 2 per cent. The value of lead pigments sold in 1928 decreased 6 per cent, the value of zinc pigments increased 6 per cent, and the value of zinc salts increased 1 per cent.

The quantity of lead pigments sold by producers in 1928 amounted to 297,734 short tons, an increase of about 1 per cent over 1927. Sales of litharge, dry white lead, basic lead sulphate, and red lead increased substantially; sales of white lead in oil decreased 6 per cent and accounted for 38 per cent of the total quantity of lead pigments sold; and sales of orange mineral decreased 35 per cent but represented an unimportant part of the total.

The quantity of zinc pigments sold in 1928 amounted to 385,595 tons, an increase of 9 per cent over 1927. Sales of lithopone increased 13 per cent, zinc oxide increased 6 per cent, while leaded zinc oxide decreased 7 per cent.

Sales of zinc chloride (50° Baumé) amounted to 38,837 short tons, an increase of 8 per cent; sales of zinc sulphate amounted to 2,293 tons as compared with 3,211 tons in 1927.

Quoted prices of white lead in oil and basic lead sulphate were constant throughout the year at figures equal to the low of the 1927 price ranges. The quotation on dry white lead was steady for the first 10 months of the year and then dropped a quarter of a cent per pound, notwithstanding a general upward trend in the price of lead during most of the year. Litharge, red lead, and orange mineral fluctuated with the price of lead, and the year ended with quotations at the same level as at the beginning. The quoted price of zinc oxide was constant throughout the year at the 1927 level. The price of lithopone was steady but slightly below the 1927 quotation.

Imports of lead pigments decreased in 1928 and were relatively unimportant. Exports, however, increased in both quantity and value and amounted to 3 per cent of the total quantity of sales by domestic producers. The principal exports were white lead and red lead.

¹ The statistics in this report were prepared (unless otherwise indicated) by H. M. Meyer and the data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the Bureau of Mines.

Imports and exports of zinc pigments as a whole increased in both quantity and value. Imports were equivalent to 3 per cent and exports 5 per cent of the domestic sales. Lithopone was the principal import and ranked second in exports, while zinc oxide was the principal export and ranked second in imports.

An outstanding feature of the lead and zinc pigment industry during the last few years has been the severe competition between white lead and other pigments for the paint trade. The effect of this is roughly indicated in the comparative sales of the pigments concerned. Sales of white lead in oil decreased from 153,000 tons in 1922 to 112,000 tons in 1928. During the same period the combined sales of zinc oxide and lithopone increased from 212,000 tons to 361,000 tons. As three-fourths of the lithopone and about one-third of the zinc oxide produced in the United States are used in the manufacture of paints, these figures indicate the marked degree to which the zinc pigments have invaded the paint industry at the expense of white lead.

The rapid expansion in the use of nitrocellulose paints in recent years has not materially altered the quantity of pigments consumed. The average nitrocellulose paint contains considerably less pigment per gallon than oil paints, but a heavy pigment priming coat and more finishing coats are used to offset the low pigment content. White lead is seldom used in these paints owing to its chemical instability in contact with nitrocellulose products. Zinc oxide and lithopone are the pigments generally used in nitrocellulose paints at the present time, but as a low pigment content is desirable an increased use of high hiding-power pigments, such as titanium oxide and zinc sulphide, is a possibility for the future.

PRODUCTION

In this chapter the pigments and salts sold are taken to represent the production, no account being taken of the stocks on hand at the beginning and end of the year. The amounts used by producers at their own plants are included under sales. The total value of lead and zinc pigments and zinc salts sold by domestic producers in 1928 was approximately \$97,974,000, as compared with \$99,026,000 in 1927 and \$106,253,000 in 1926. The following tables show the production of lead and zinc pigments and zinc salts as reported to the Bureau of Mines:

Lead pigments sold by domestic manufacturers in the United States, 1919-1928, in short tons

Year	White lead		Basic lead sulphate or sublimed lead		Red lead	Orange mineral	Litharge
	Dry	In oil	White	Blue			
1919.....	30,085	109,005	9,068	1,350	¹ 32,362	(¹)	46,739
1920.....	33,678	112,017	12,412	928	¹ 34,431	(¹)	62,329
1921.....	26,738	143,545	11,568	463	21,805	381	41,909
1922.....	41,598	153,393	13,765	972	30,509	370	58,261
1923.....	37,786	125,087	11,949	800	38,037	646	75,107
1924.....	42,622	144,872	14,572	1,088	36,813	331	74,724
1925.....	43,426	120,479	14,996	1,090	41,669	840	86,546
1926.....	37,968	111,845	12,271	1,236	42,550	813	82,540
1927.....	38,669	119,026	13,482	1,061	39,073	709	81,655
1928.....	42,049	111,923	16,002	1,234	40,497	459	85,570

¹ Figures for red lead include orange mineral prior to 1921.

Lead pigments sold by domestic manufacturers in the United States, 1927 and 1928

	1927			1928		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Basic lead sulphate or sublimed lead:						
White.....	13,482	\$2,027,333	\$150	16,002	\$2,211,470	\$138
Blue.....	1,061	168,416	159	1,234	175,508	142
Red lead.....	39,073	6,980,042	179	40,497	6,816,876	168
Orange mineral.....	709	178,457	252	459	112,521	245
Litharge.....	81,655	13,064,046	160	85,570	12,872,730	150
White lead:						
Dry.....	38,669	6,767,385	175	42,049	6,688,115	159
In oil.....	119,026	27,770,000	233	111,923	24,553,989	219

Zinc pigments and salts sold by domestic manufacturers in the United States, 1919-1928, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° Baumé)	Zinc sulphate
1919.....	117,639	27,591	78,365	¹ 59,228	¹ 2,763
1920.....	99,444	30,460	89,373	¹ 68,945	¹ 3,072
1921.....	74,329	16,103	55,016	59,457	3,295
1922.....	128,465	19,613	83,360	41,627	5,078
1923.....	126,987	23,504	98,199	42,431	5,375
1924.....	131,470	26,729	109,469	51,054	4,674
1925.....	151,354	31,750	145,019	45,619	5,332
1926.....	146,923	23,859	159,931	45,724	3,649
1927.....	151,246	26,064	176,994	36,096	3,211
1928.....	160,904	24,223	200,468	38,837	2,293

¹ Figures cover production, not sales.*Zinc pigments and salts sold by domestic manufacturers in the United States, 1927 and 1928*

	1927			1928		
	Short tons	Value (at plant, exclusive of container)		Short tons	Value (at plant, exclusive of container)	
		Total	Average		Total	Average
Zinc oxide ¹	151,246	\$19,887,212	\$131	160,904	\$20,685,442	\$129
Leaded zinc oxide ¹	26,064	3,193,014	123	24,223	2,945,323	122
Lithopone.....	176,994	17,163,620	97	200,468	19,073,914	95
Zinc chloride, 50° Baumé.....	36,096	1,640,446	45	38,837	1,706,222	44
Zinc sulphate.....	3,211	185,865	58	2,293	132,235	58

¹ Zinc oxide containing 5 per cent or more of lead is classed as leaded zinc oxide.

Statistics for lead arsenate, lead acetate, zinc stearate, and other lead and zinc salts and compounds are collected biennially by the Bureau of the Census for odd years. The following tables show the production (exclusive of pigments) during the past few years.

Lead acetate, lead arsenate, and other lead salts (exclusive of lead pigments) produced in the United States, 1919, 1921, 1923, 1925, and 1927

Year	Lead acetate			Lead arsenate		Other salts
	Total production	Produced for sale		Produced for sale (short tons)	Value		Value
	Short tons	Short tons	Value			
1919.....	2,566	2,092	\$552,435	5,733	\$2,090,341	\$335,906
1921.....	1,408	372	90,305	4,615	1,629,446	120,327
1923.....	2,753	616	160,133	5,378	2,229,431	388,868
1925.....	3,432	1,251	359,686	5,969	1,777,552	192,995
1927.....	(1)	1,508	395,122	² 10,764	² 3,190,257	254,809

¹ Not given.

² The statistics for 1927 are not comparable with those for preceding years as the figures prior to 1927 do not include data for the production reported by establishments engaged primarily in the manufacture of patent and proprietary medicines and compounds.

Zinc stearate and other salts and compounds of zinc (exclusive of zinc pigments, zinc chloride, and zinc sulphate) produced in the United States, 1923, 1925, and 1927

Year	Zinc stearate		Other salts and compounds, value
	Short tons	Value	
1923-----	227	\$107,319	\$410,913
1925-----	393	169,051	420,944
1927-----	391	164,927	376,666

COMPETITION BETWEEN PIGMENTS

Throughout the nineteenth century white lead was used almost exclusively as the pigment base in the manufacture of paints, but during the last 25 years its dominant position has been challenged by the competition of zinc oxide and lithopone. The increasing use of these two pigments, particularly lithopone, is due to their lower first cost and to the constantly improved properties that have been attained as a result of scientific research on the part of the producers. Production of lithopone has increased from less than 30,000 tons in 1913 to more than 200,000 tons in 1928, three-fourths of which is used in the manufacture of paint.

Another influencing factor in the pigment industry has been the development of nitrocellulose paint, lacquer, and enamels. Nitrocellulose paint was developed for use in the automotive industry, in which the practice of mass production required a satisfactory paint that would dry quickly and thus assist in speeding up the production process. During the past few years, however, its use has extended to many other branches of industry; in 1927 more than 11,000,000 gallons of nitrocellulose paint, lacquer, and enamels were produced. This represents between 10 and 15 per cent of the total volume of

paint and varnish produced in the United States and is an increase of 40 per cent over 1926. Although it is impossible to gage accurately the effect of this product on the mineral pigment industry, two points of interest may be noted. First, the growing use of nitrocellulose paint is limiting the field of white lead, which is not used extensively on account of its chemical instability in contact with nitrocellulose products. Lithopone, zinc oxide, and titanox are used most widely, titanox being a recent development. The second point of interest is that, notwithstanding the lower pigment content per gallon of nitrocellulose paint, there probably will be no material change in the quantity of pigment used per unit of painted surface because a heavy-pigment base coat and more finishing coats are required.

Titanium pigments have been increasing in importance recently, especially since the development of titanox. Titanox consists of 25 per cent of titanium oxide and 75 per cent of barium sulphate. It is claimed that this pigment excels the lead and zinc pigments in hiding power and inertness; consequently, it is finding an increasing market with the nitrocellulose paint manufacturers. In oil paints it is used chiefly in interior enamels and mixed with zinc oxide in exterior paints. Used alone in exterior paints it has not as yet proved satisfactory. Extensive development of titanium pigments in the past has been retarded by limited sources of raw materials and high cost of production; recently, however, new sources and processes have been developed, and it now appears that titanium will invade the field of lead and zinc pigments. The fact is significant that the National Lead Co., one of the most important pigment producers in the United States, has secured a commanding position in the world titanium field.

The poisonous qualities of white lead have long been the subject of much discussion which at times has resulted in legislation directed against its use, particularly in France and Belgium. In February, 1928, a royal decree was issued in Spain which provided that after November, 1928, the use of paints containing more than 2 per cent of lead for interiors would be prohibited except for such jobs as are authorized by the Ministry of Labor. It also provided that all paint preparations containing lead must be labeled "poisonous." No legislation of this nature has as yet developed in the United States.

In the lead and zinc pigment industry white lead may be characterized as competing against the field. Although the exact effect of this competition on the consumption of white lead in the paint industry can not be accurately gaged, undoubtedly the progress of the white-lead industry has been seriously hampered. The use of zinc oxide and lithopone will probably increase with further use of nitrocellulose paint, in which white lead is seldom used. Legislation in Europe is tending to restrict the use of lead paints on account of their poisonous qualities. Further development of titanium pigments will probably provide competition for both lead and zinc pigments, lead pigments bearing the brunt on account of their higher prices.

A red pigment known as minium of aluminum is being manufactured in France by dehydrating, grinding, and classifying selected grades of bauxite. This pigment has been used for several years by the railways of France as a substitute for red lead, and when mixed with oil it is said to have a greater covering power than red lead.

Zinc sulphide has long been noted for its excellent pigment qualities and is one of the principal constituents of lithopone. Its use unmixed as a pigment, however, has been very limited in the past owing to its comparatively high cost, but recently it has been used in increasing amounts. In 1928 the production of zinc sulphide for market was reported, but the amount produced can not be disclosed as disclosure would divulge confidential information. Imports increased from 132,000 pounds in 1927 to 338,000 pounds in 1928.

CONSUMPTION OF LITHOPONE

Through the cooperation of the producers of lithopone the Bureau of Mines is able to show the distribution of lithopone sales in 1927 and 1928.

Distribution of lithopone sales by industries, 1927 and 1928

	1927		1928	
	Short tons	Per cent	Short tons	Per cent
Paints, varnish, lacquers.....	131,145	74.1	149,122	74.4
Floor coverings and textiles.....	31,186	17.6	35,416	17.7
Rubber.....	7,653	4.3	6,898	3.4
Other uses.....	7,010	4.0	9,032	4.5
	176,994	100.0	200,468	100.0

Lithopone producers reported an annual productive capacity of 202,000 tons at the end of 1927 and 227,000 tons at the end of 1928.

SOURCE

The following table gives the quantity and source of the lead and zinc contained in the pigments and salts produced in the United States in 1927 and 1928. It shows that in 1928, 96 per cent of the lead in lead pigments was derived from pig lead, 4 per cent from ore, and less than $\frac{1}{2}$ per cent from secondary material. For zinc pigments the proportions were 70 per cent from ore, 21 per cent from metal, and 9 per cent from secondary material. The zinc in zinc salts is derived largely from secondary material.

Metal content of lead pigments and zinc pigments and salts produced by domestic manufacturers, 1927 and 1928, by sources, in short tons

Source	1927			1928		
	Lead in pigments ¹	Zinc in—		Lead in pigments ¹	Zinc in—	
		Pigments	Salts		Pigments	Salts
Domestic ore.....	13,136	121,899	47	10,465	123,964	126
Metal.....	242,713	34,008	4	242,914	37,584	4
Secondary material ²	1,246	13,972	9,544	654	14,890	10,463
	257,095	169,879	9,595	254,033	176,438	10,593

¹ Includes also lead recovered in zinc oxide and leaded zinc oxide. The metal content of lead acetate and lead arsenate is not available, as no canvass of their production is made by the Bureau of Mines. Moreover, these salts are derived from pig lead, and their metal content has already been taken into statistical account in the figures covering lead production.

² Zinc ashes, skimmings, drosses, and old metal.

The American Bureau of Metal Statistics reported that the following quantities of zinc materials were used in the manufacture of lithopone in 1928: Roasted ore, 35,805 tons; galvanizer's ashes, 12,210 tons; and zinc oxide and fume, 8,000 tons. In addition, a small amount of slab zinc was used which was omitted from the above accounting to avoid disclosing confidential information.

PREPARATION AND USES

WHITE LEAD

White lead is the basic carbonate of lead and is the oldest and most important of the white pigments used in oil paint. The properties of white lead that contribute to its usefulness in paint are its very great hiding power and the facility with which white-lead paint can be worked with a brush. Owing to its relatively high first cost and the fact that white-lead paints are blackened by compounds containing sulphur, the use of less-expensive zinc oxide and lithopone as paint pigments has increased during recent years and has seriously retarded expansion of the white-lead industry.

The largest part of the white lead manufactured in the United States is produced by the "stack" or old Dutch process, wherein perforated disks of high-grade metallic lead, called buckles, about 6 inches in diameter, are placed in small clay pots, each of which has a well in the bottom containing dilute acetic acid. These pots are arranged in tiers within a large room. Each tier is covered with boards and a layer of spent tanbark. The lead is corroded to the basic carbonate by the action of acetic acid vapor and CO_2 . The CO_2 and the heat necessary to vaporize the acetic acid are produced by the fermentation of the tanbark. The process requires from three to four months for completion. The corroded lead buckles are washed, crushed, screened, and ground in water, and the pulp is either dried to form dry white lead or ground with oil without drying to form the oil pigment. In the United States about three-fourths of the product is ground in oil.

Some white lead is also made by the Carter process and the electrolytic process. In the former metallic lead is finely divided by a jet of steam and is then treated with dilute acetic acid and carbon dioxide in slowly rotating wooden cylinders. The process is completed in about 12 days.

In the electrolytic process a lead anode and an iron cathode are used, each of which has an independent continuous circulation of electrolyte kept separate by a porous diaphragm. The electrolytes are solutions of sodium acetate containing sodium carbonate. The anolyte contains the exact amount of carbonate necessary to precipitate the basic lead carbonate, whereas the catholyte contains a relatively large amount of carbonate. During electrolysis the lead dissolves at the anode surface and is immediately precipitated as the basic carbonate in suspension in the anolyte. At the same time CO_3 is generated at the cathode, passes through the diaphragm, and replaces the CO_3 precipitated with the lead, thus maintaining the anolyte at a constant concentration. The catholyte passes through a carbon-dioxide absorption tower where it is restored to its original strength. The basic lead carbonate is filtered from the anolyte, washed, dried, and barreled.

It is estimated that more than 85 per cent of the white lead produced in the United States is used in the manufacture of paint. It is the only important white pigment that is used unmixed with other pigments in oil paints; it is also used in varying proportions in many mixed pigments. The dry white lead is used in paints, as a constituent of the glaze used in the finer grades of pottery, and to some extent in the manufacture of rubber.

The United States produces an export surplus of about 6,000 tons annually, most of which is manufactured in bond from foreign lead.

BASIC LEAD SULPHATE

Basic lead sulphate is also known as sublimed lead and is marketed in two forms, "white" and "blue." The white variety is usually made by vaporizing powdered galena at a high temperature in the presence of air, which oxidizes it to the basic sulphate. The resultant fume is collected in bags, and owing to the zinc content of the ore used it usually contains about 5 per cent of zinc oxide. This product is usually not as white as basic carbonate white lead but has a more stable color in the presence of sulphur gases. It is used chiefly in the manufacture of prepared paints and mixed pigments. A small amount is used in the manufacture of rubber. Some sublimed lead is made from pig lead.

The blue variety is generally a by-product of the smelting of pig lead and is collected from the fumes leaving the smelting furnaces. Its color is due to small amounts of carbon and lead sulphide. Paints made from blue lead are especially useful as protective coatings on metallic surfaces. Some blue lead is also used in the manufacture of rubber.

LITHARGE

Litharge is the monoxide of lead and is produced by the oxidation of molten lead at a moderate temperature in a reverberatory furnace. The oxide forms on the surface of the molten metal and is raked off into iron pots. The texture and color of the litharge, which affect its use in the various industries, are controlled by the temperature of the furnace and the method of cooling. The chief use of litharge is in the manufacture of storage-battery plates. The negative plates are usually made of straight litharge, whereas the positive plates are a mixture of red lead and litharge. It is estimated that more than half the litharge produced in the United States is used in the battery industry. The second largest use of litharge is in the rubber industry where it acts as a cure accelerator and toughener in the production of mechanical rubber goods and rubber clothing. Other uses are in the manufacture of lead-chromate color pigment, in the refining of petroleum products, in the manufacture of insecticides, pottery glaze, and enamel ware, in making glass, and as a drier in the manufacture of varnish and linoleum.

RED LEAD

Red lead is the tetroxide of lead and is made by heating powdered litharge at a moderate temperature in a "coloring oven." The marketed product varies in composition, averaging about 85 per cent pure red lead and 15 per cent litharge; the latter is unchanged

in the process of manufacture. About two-thirds of the total production is used in the manufacture of storage-battery plates. It is an important pigment in paints used as a protective coating on metal surfaces and accounts for the familiar orange color seen on practically all steel construction. Red lead is the most important of the lead compounds used in the production of flint and optical glass. It is also used in potter's glaze, enamel ware, and as a drier in the manufacture of varnish.

ORANGE MINERAL

Orange mineral is a form of red lead; it has the same chemical composition but differs in physical properties and has a lower specific gravity and lighter color. It is usually made by roasting white lead under a process that requires great care and skill. Consequently, the price is higher than that for any of the other lead pigments. Orange mineral is used chiefly in the manufacture of an artificial vermilion color pigment known as eosin lake; it is also used in the production of printer's inks and enamels.

ZINC OXIDE

Zinc oxide, the monoxide of zinc, is made by two processes in the United States—the French and the American. In the former metallic zinc is heated in a current of air, and the resulting oxide fume is collected in long chambers. The product is graded according to its fineness and is labeled "white seal," "green seal," or "red seal." The white-seal variety is the finest and whitest grade. Its specific gravity is much lower than the specific gravities of the coarser grades. It is used chiefly in high-grade enamel paints. Green seal and red seal are the intermediate and heavy grades, respectively.

American process zinc oxide is made by heating a mixture of zinc ore and anthracite coal to produce a metallic zinc vapor, which in turn is treated with air to form the oxide. The oxide fume is collected in bag houses. As lead is usually present in the ore, the resulting oxide contains some lead compounds. It is usually not quite as white as French oxide but in other respects is very similar. The American process of making zinc oxide predominates in the United States.

Zinc oxide has been used as a paint pigment to a moderate extent for several centuries, but the increase in production in the United States during the twentieth century has been due mainly to the growth of the rubber industry. In an estimate made in January, 1926,² the use of zinc oxide in the various industries was given as follows:

	Per cent		Per cent
Rubber.....	53	Ceramics.....	3
Paints and enamels.....	33	Miscellaneous.....	2
Oilcloth and linoleum.....	5		
Exports.....	4		100

Zinc oxide is used in the manufacture of rubber because of the beneficial properties it imparts to rubber. It increases the tensile strength and the resistance to abrasion and tear and improves the aging qualities by counteracting the tendency of rubber goods to deteriorate

² Chemical and Metallurgical Engineering, vol. 33, January, 1926, p. 55.

under action of light and heat. All of these properties are essential in making automobile tires, tubes, and accessories, which represent about 75 per cent of the entire rubber industry.

Zinc oxide is seldom used alone as a paint pigment as it dries to a hard smooth surface which on aging tends to crack and peel off, leaving an unsatisfactory surface for repainting. It has a more stable color and costs less than white lead, has excellent white color and covering properties, and is durable. These many advantages make zinc oxide a useful constituent of mixed paints, in which it finds a large usage. It is generally mixed with lithopone, white lead, and inert pigments.

Zinc oxide is also used in the manufacture of oilcloth and linoleum, pottery glazes and glass, celluloid, druggists' supplies, printer's inks, leather finishes, and for many other purposes.

The United States produces an exportable surplus of about 13,000 tons annually.

LEADED ZINC OXIDE

Leaded zinc oxide is made by a method similar to the American process of making zinc oxide. The ore used contains lead in varying proportions, and the finished product may contain from 5 to 35 per cent of basic lead sulphate. The properties of this pigment are similar to those of zinc oxide and basic lead sulphate. It has fair hiding power but is not so white as American process zinc oxide. Leaded zinc oxide is used chiefly in the manufacture of paint.

LITHOPONE

Lithopone is the newest of the important white pigments, and its introduction into the United States dates back to the close of the nineteenth century. It contains about 70 per cent of barium sulphate and about 30 per cent of zinc sulphide. The latter, a powerful pigment, is responsible for the useful pigment qualities of lithopone. The process of manufacture consists in mixing proper proportions of solutions of barium sulphide and zinc sulphate. The resulting precipitate is heated to a red heat and plunged into cold water, after which it is ground, dried, and powdered.

The use of lithopone in the United States has increased rapidly and has spread to many industries. Its chief use is in paint manufacture, in which it is favored on account of its low cost and many good qualities. Formerly the use of lithopone was confined to interior paint, as the pigment would discolor in sunlight. In recent years, however, the refining process has been changed, and it is claimed that lithopone with a stable color suitable for exterior paints is now being produced. It is generally mixed with other pigments, notably zinc oxide.

A large quantity of lithopone is used in the manufacture of oilcloth and linoleum, artificial leather finishes, window shades, and printer's inks. The distribution of the 1927 and 1928 sales of lithopone is given on page 352.

The United States has a small excess of lithopone imports over exports.

ZINC SALTS

Zinc sulphate, sometimes known as white vitriol, usually is made by treating secondary zinc material with dilute sulphuric acid, which upon evaporation yields the white crystalline salt. It is used to some extent in calico printing and in dyeing, as a drier for linseed oil, as a disinfectant and astringent, and as a sizing on cement prior to painting. In addition to these uses, several thousand tons are used yearly in the manufacture of lithopone, but as this represents an intermediate product it is not separately recorded by the Bureau of Mines.

Zinc chloride may be prepared by treating zinc directly with chlorine or with hydrochloric acid, the latter being more generally used. Practically all zinc chloride produced in the United States is made from scrap metal or secondary materials, such as drosses, ashes, skimmings, and galvanizer's scrap. Owing to its hygroscopic properties it is usually marketed in solution, although the fused salt may be obtained in air-tight containers. Zinc chloride is used chiefly as a preservative of timber but is also used as a germicide and disinfectant, in the refining of petroleum, in the textile industry, in the manufacture of hard fiber, for medical purposes, and in dentistry.

PRODUCERS AND PLANTS

The following companies reported sales of lead and zinc pigments and zinc salts of their own production in 1928.

White lead:

Anaconda Lead Products Co. (electrolytic process).....	East Chicago, Ind.
Carter White Lead Co.....	West Pullman, Chicago, Ill.
E. I. du Pont de Nemours & Co.....	Philadelphia, Pa.
Eagle-Picher Lead Co.....	East St. Louis, Ill.
Do.....	Cincinnati, Ohio.
Euston Lead Co.....	Scranton, Pa.
W. P. Fuller & Co.....	South San Francisco, Calif.
John T. Lewis & Bros. Co.....	Philadelphia, Pa.
National Lead Co. of California.....	Melrose, Calif.
National Lead Co.....	Chicago, Ill.
Do.....	St. Louis, Mo.
Do.....	Brooklyn, N. Y.
Do.....	Port Richmond, N. Y.
Do.....	Cincinnati, Ohio.
National Lead & Oil Co. of Pennsylvania.....	New Kensington, Pa.
Sherwin-Williams Co.....	Chicago, Ill.
United Lead Co.....	Perth Amboy, N. J.
Wetherill & Bro.....	Philadelphia, Pa.

Basic lead sulphate, or sublimed lead:

Eagle-Picher Lead Co.....	Galena, Kans.
Do.....	Joplin, Mo.
St. Louis Smelting & Refining Works of National Lead Co.....	Collinsville, Ill.

Red lead, orange mineral, and litharge:

Eagle-Picher Lead Co.....	East St. Louis, Ill.
Do.....	Joplin, Mo.
Do.....	Newark, N. J.
Do.....	Cincinnati, Ohio.
Evans Lead Co.....	Charleston, W. Va.
Franklin Lead Oxide Co.....	Franklin, Pa.
W. P. Fuller & Co.....	South San Francisco, Calif.
Grasselli Chemical Co.....	East Chicago, Ind.

Red lead, orange mineral, and litharge—Continued.

Harshaw Chemical Co.....	Cleveland, Ohio.
John T. Lewis & Bros. Co.....	Philadelphia, Pa.
Metals Refining Co.....	Hammond, Ind.
National Lead Co. of California.....	Melrose, Calif.
National Lead Co.....	Chicago, Ill.
Do.....	St. Louis, Mo.
Do.....	Brooklyn, N. Y.
National Lead & Oil Co. of Pennsylvania.....	New Kensington, Pa.
Sherwin-Williams Co.....	Chicago, Ill.
Wetherill & Bro.....	Philadelphia, Pa.

Zinc oxide and leaded zinc oxide:

American Zinc Co. of Illinois.....	Hillsboro, Ill.
American Zinc Oxide Co.....	Columbus, Ohio.
Eagle-Picher Lead Co.....	Hillsboro, Ill.
Empire Zinc Co.....	Canon City, Colo.
Grasselli Chemical Co.....	East Chicago, Ind.
International Lead Refining Co. (French process).....	East Chicago, Ind.
Do. (French process).....	Akron, Ohio.
Mineral Point Zinc Co.....	Mineral Point, Wis.
New Jersey Zinc Co. (of Pennsylvania).....	Palmerton, Pa.
Do. (French process).....	Freemansburg, Pa.
Ozark Smelting & Mining Co.....	Coffeyville, Kans.
River Smelting & Refining Co.....	Florence, Colo.

Lithopone:

Chemical & Pigment Co. (Inc.).....	Oakland, Calif.
Do.....	Collinsville, Ill.
Do.....	St. Helena, Md.
E. I. du Pont de Nemours & Co.....	Newark, N. J.
Do.....	Philadelphia, Pa.
Eagle-Picher Lead Co.....	Argo, Ill.
Grasselli Chemical Co.....	Grasselli, N. J.
Krebs Pigment & Chemical Co.....	Newport, Del.
Mineral Point Zinc Co.....	Depue, Ill.
New Jersey Zinc Co. (of Pennsylvania).....	Palmerton, Pa.
Sherwin-Williams Co.....	Chicago, Ill.
United Color & Pigment Co.....	Newark, N. J.

Zinc salts:

Arkansas Preservative Co.....	North Little Rock, Ark.
Charles Cooper & Co.....	Newark, N. J.
General Chemical Co.....	Chicago, Ill.
Grasselli Chemical Co.....	East Chicago, Ind.
Do.....	Grasselli, N. J.
Do.....	Cleveland, Ohio.
Do.....	Weirton, W. Va.
Harshaw Chemical Co.....	Cleveland, Ohio.
Charles Lennig & Co. (Inc.).....	Philadelphia, Pa.
Merrimac Chemical Co.....	Everett, Mass.
Monsanto Chemical Works.....	Monsanto, Ill.
Ozark Smelting & Mining Co.....	Coffeyville, Kans.

IMPORTS AND EXPORTS

Lead pigments.—Imports of lead pigments into the United States are relatively insignificant. In 1928 imports of white lead and red lead decreased, while imports of litharge and orange mineral increased. Exports of white-lead pigments increased 7 per cent in 1928 and amounted to 4 per cent of the total domestic output of basic carbonate white lead. United Kingdom took 66 per cent of the white-lead pigments exported in 1928. Combined exports of red lead and litharge increased 46 per cent and amounted to 2 per cent of the total domestic production of these two pigments.

Basic carbonate white lead, red lead, litharge, and orange mineral imported for consumption in the United States, 1919-1928

Year	Basic carbonate white lead		Red lead		Litharge		Orange mineral	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1919.....	21, 213	\$2, 490	7, 199	\$1, 136	-----	-----	39, 781	\$5, 082
1920.....	159, 977	19, 449	23, 076	1, 789	21, 002	\$2, 647	52, 094	5, 352
1921.....	124, 176	12, 598	12, 236	689	100	7	77, 937	7, 830
1922.....	222, 465	21, 335	1, 405	94	1, 770	162	111, 419	9, 729
1923.....	336, 892	31, 386	3, 600	220	22, 525	1, 314	116, 293	9, 031
1924.....	141, 156	13, 478	1, 874	155	1, 838	193	99, 341	8, 047
1925.....	213, 028	21, 535	3, 452	268	2, 417	330	58, 522	6, 278
1926.....	297, 567	31, 690	9, 591	817	1, 122	13	58, 104	5, 143
1927.....	330, 421	29, 901	51, 688	4, 403	1, 182	133	44, 866	3, 816
1928.....	166, 236	15, 889	24, 675	1, 510	2, 100	153	62, 409	5, 227

White lead and red lead exported from the United States, 1919-1928

Year	White lead ¹		Red lead ²	
	Short tons	Value	Short tons	Value
1919.....	14, 017	\$3, 037, 292	3, 114	\$735, 177
1920.....	14, 901	3, 195, 101	1, 532	365, 575
1921.....	5, 161	993, 130	548	115, 500
1922.....	4, 598	710, 765	1, 683	294, 133
1923.....	¹ 5, 172	836, 261	² 1, 840	372, 828
1924.....	¹ 5, 055	853, 444	² 940	210, 598
1925.....	¹ 6, 832	1, 293, 168	802	183, 591
1926.....	¹ 6, 239	1, 119, 350	775	175, 273
1927.....	¹ 6, 047	947, 226	² 1, 429	271, 376
1928.....	¹ 6, 476	952, 316	² 2, 084	364, 995

¹ Exports of white lead and basic lead sulphate or sublimed lead not classified separately after 1922; the figures for 1923-1928 may include an unknown quantity of basic lead sulphate or sublimed lead.

² Exports of red lead and litharge not classified separately for 1923-24 and 1927-28; the figures for those years may include an unknown quantity of litharge. Figures for other years are for red lead only.

White lead ¹ exported from the United States, 1927-28, by destinations

Destination	1927		1928	
	Short tons	Value	Short tons	Value
North America:				
Canada.....	61	\$10, 388	58	\$9, 285
Cuba.....	48	10, 524	80	14, 750
Mexico.....	105	25, 208	149	32, 640
Panama.....	356	67, 831	284	57, 022
Other.....	88	20, 818	84	17, 517
	658	134, 769	655	131, 214
South America:				
Brazil.....	(²)	89	45	7, 043
Colombia.....	30	6, 846	13	2, 599
Uruguay.....	48	7, 771	41	5, 857
Venezuela.....	29	6, 148	7	1, 566
Other.....	535	92, 907	402	59, 370
	642	113, 761	508	76, 435
Europe:				
Netherlands.....	579	77, 947	657	87, 528
United Kingdom.....	4, 007	580, 256	4, 274	586, 507
Other.....	2	364	64	10, 797
	4, 588	658, 567	4, 995	684, 832
Asia:				
Philippine Islands.....	144	35, 241	214	41, 294
Other.....	4	946	99	17, 526
	148	36, 187	313	58, 820
Africa.....	1	279	1	163
Oceania, including Australia.....	10	3, 663	4	852
	6, 047	947, 226	6, 476	952, 316

¹ White lead and basic lead sulphate or sublimed lead not classified separately after 1922; the figures may include an unknown quantity of basic lead sulphate or sublimed lead.

² Less than 1 ton.

Zinc pigments and salts.—Lithopone is the principal zinc pigment imported into the United States. Imports of lithopone increased 24 per cent in 1928 and were equivalent to 5 per cent of the domestic output. Imports of zinc oxide did not change materially in 1928; they were equivalent to less than 1 per cent of the domestic production. Imports of zinc sulphide have increased from about 8,000 pounds in 1926 to 338,000 pounds in 1928. Imports of zinc chloride and zinc sulphate increased substantially in 1928. The Netherlands supplies about 75 per cent of the zinc pigments imported into the United States.

Zinc oxide is the principal zinc pigment exported from the United States; in 1928 there was a slight increase in the quantity shipped abroad. Exports amounted to 9 per cent of the domestic output. Canada took 43 per cent of the total, and United Kingdom took 29 per cent. Exports of lithopone increased 58 per cent; imports, however, exceeded exports by 6,600 tons, or the equivalent of 3 per cent of the United States output.

Zinc oxide, lithopone, zinc sulphide (white), zinc chloride, and zinc sulphate imported for consumption in the United States, 1919–1928

Year	Zinc oxide				Lithopone	
	Dry		In oil		Short tons	Value
	Short tons	Value	Short tons	Value		
1919.....	105	\$44,338	3	\$1,351	739	\$122,708
1920.....	1,431	289,890	14	3,596	1,714	263,240
1921.....	1,286	145,071	57	17,549	5,247	432,019
1922.....	2,712	361,599	42	8,595	10,763	885,671
1923.....	1,036	169,415	89	21,934	10,440	776,383
1924.....	1,703	229,629	110	25,874	6,830	543,025
1925.....	1,274	205,582	132	31,187	6,330	478,395
1926.....	1,127	198,897	94	23,163	8,686	661,700
1927.....	1,399	220,427	77	18,619	7,979	656,166
1928.....	1,348	208,557	107	25,620	9,885	808,200

Year	Zinc sulphide ¹		Zinc chloride		Zinc sulphate	
	Pounds ¹	Value	Short tons	Value	Short tons	Value
1919.....	10,035	\$4,413	1	\$192	(²)	\$152
1920.....	45,482	15,027	565	76,495	50	3,038
1921.....	93,537	8,330	2,199	213,995	17	820
1922.....	27,159	8,453	1,374	87,509	17	1,064
1923.....	11,844	5,403	551	44,164	20	3,466
1924.....	9,678	5,727	319	28,911	13	1,265
1925.....	14,604	5,589	469	50,712	17	1,368
1926.....	7,800	4,125	568	51,605	66	4,590
1927.....	132,223	22,984	470	40,069	205	9,390
1928.....	338,090	47,235	563	47,185	683	28,866

¹ Zinc sulphide is stated in pounds rather than tons because of its high value and smaller quantities.

² Less than 1 ton.

Zinc oxide and lithopone exported from the United States, 1919-1928

Year	Zinc oxide		Lithopone	
	Short tons	Value	Short tons	Value
1919.....	14, 703	\$3, 059, 276	(1)	(1)
1920.....	11, 164	2, 151, 544	(1)	(1)
1921.....	2, 511	426, 253	(1)	(1)
1922.....	3, 977	593, 128	1, 616	\$169, 982
1923.....	5, 024	743, 577	1, 485	176, 024
1924.....	3, 927	605, 630	923	104, 783
1925.....	10, 855	1, 503, 561	1, 287	132, 771
1926.....	14, 661	1, 917, 420	1, 941	200, 412
1927.....	14, 494	1, 821, 786	2, 110	222, 585
1928.....	14, 799	1, 849, 889	3, 326	337, 565

¹ Not classified separately prior to 1922.

Zinc oxide exported from the United States, 1927 and 1928, by destinations

Destination	1927		1928	
	Short tons	Value	Short tons	Value
North America:				
Canada.....	5, 544	\$763, 772	6, 404	\$882, 180
Cuba.....	45	7, 563	135	20, 288
Mexico.....	87	16, 584	102	19, 112
Panama.....	73	13, 949	94	17, 291
Other.....	36	7, 498	30	5, 657
	5, 785	809, 366	6, 765	944, 528
South America:				
Brazil.....	14	2, 674	8	1, 663
Other.....	131	26, 380	120	22, 011
	145	29, 054	128	23, 674
Europe:				
France.....	1, 708	189, 132	(1)	93
Italy.....	685	77, 823	247	29, 270
United Kingdom.....	3, 410	396, 750	4, 315	491, 658
Other.....	1, 835	206, 012	1, 859	186, 144
	7, 638	869, 717	6, 421	707, 165
Asia:				
Philippine Islands.....	99	12, 709	93	11, 111
Other.....	711	84, 390	1, 130	129, 375
	810	97, 099	1, 223	140, 486
Africa.....	5	810	4	724
Oceania, including Australia.....	111	15, 740	258	33, 312
	14, 494	1, 821, 786	14, 799	1, 849, 889

¹ Less than 1 ton.

PRICES AND VALUE

The total value and the average price received by producers from sales of lead and zinc pigments and salts are given on preceding pages of this chapter. The range of market quotations as reported by the Oil, Paint and Drug Reporter is shown in the following table.

Range of quotations on lead pigments and zinc pigments and salts at New York, 1926-1928, in cents a pound

Product	1926	1927	1928
Basic lead sulphate, or sublimed lead, dry, in casks.....	9.00-10.00	7.75- 9.00	7.75
White lead, or basic lead carbonate:			
Dry, in casks.....	9.75-10.75	8.50- 9.75	8.25- 8.50
In oil, carload lots.....	12.15-12.36	10.73-12.15	10.73
Litharge, American, commercial powdered, casks.....	10.50-11.75	8.75-10.75	8.50- 9.00
Red lead, dry, in casks.....	11.00-12.25	9.75-11.25	9.50-10.00
Orange mineral, American, casks.....	13.25-14.50	11.75-13.50	11.50-12.00
Lead acetate, brown, broken, barrels.....	13.00-14.50	12.00-13.50	12.00-12.50
Lead arsenate, powdered, drums.....	10.00-12.00	13.50-15.00	13.00-15.00
Zinc oxide:			
American process, lead-free, bags, car lots.....	6.50- 7.25	6.50	6.50
American process, leaded, barrels, car lots.....	6.50- 8.00	6.75- 6.88	6.88
French process, red seal, bags, car lots.....	9.38-10.13	9.38	9.38
French process, green seal, bags, car lots.....	10.38-11.13	10.38	10.38
French process, white seal, barrels, car lots.....	11.63-12.38	11.63	11.63
Lithopone, American, bags, car lots.....	5.38- 5.63	5.38	5.25
Zinc chloride:			
Solution, ¹ drums.....	3.00- 4.25	2.75- 4.00	2.75- 3.25
Fused.....	5.25- 6.00	5.25	5.25
Zinc sulphate, barrels.....	3.00- 4.00	3.00- 3.75	3.50- 3.75

¹ Reported as "paste, barrels," in 1926.

² At works.

Quotations on basic lead sulphate and white lead in oil were constant throughout the year, notwithstanding an upward trend in the price of lead during most of the year. Dry white lead was quoted at 8½ cents during the first 10 months, but in November it was cut to 8¼ cents. Quotations on litharge, red lead, and orange mineral fluctuated with the lead market and were the same at the end of the year as at the beginning. The range of quotations on lead acetate and lead arsenate was lower in 1928.

Quotations on zinc oxide and lithopone were constant throughout the year, although the price of zinc increased steadily from February to December. The price range of zinc chloride was lower in 1928, while that of zinc sulphate was somewhat higher.

ZINC ¹

By ELMER W. PEHRSON ²

GENERAL SUMMARY

Salient figures of the zinc industry in the United States, 1927-28

	1927	1928
Production of primary zinc:		
From domestic ores.....short tons..	576,960	591,525
From foreign ores.....do.....	15,556	11,056
	592,516	602,581
Apparent consumption of primary zinc.....do.....	516,373	578,060
Stocks of zinc on hand at smelters Dec. 31.....do.....	53,522	48,432
Ratio of electrolytic zinc to total primary zinc production.....per cent.....	19.01	26.58
Recovery of unalloyed secondary zinc.....short tons..	64,800	70,700
Prices per pound of prime western zinc at St. Louis:		
Average for year.....cents.....	6.25	6.03
Highest monthly average.....do.....	6.71	6.35
Lowest monthly average.....do.....	5.73	5.55
Mine production of recoverable zinc.....short tons..	718,541	695,170
Tri-State district (Joplin region).....per cent of total..	46	43
Western States.....do.....	32	33
Other.....do.....	22	24
World smelter production of zinc.....short tons..	1,450,000	1,555,000

From a statistical point of view the decline in the zinc industry of the United States, which began in the latter part of 1925, came to a definite end early in 1928, and during the balance of that year definite improvement was noted in the basic phases of the industry. The price, although considerably under the average for 1927, increased consistently after February. The St. Louis quotation was 5.65 cents per pound at the beginning of the year, reached a low of 5.40 cents the latter part of February, and thereafter climbed to a high of 6.35 cents, which was maintained throughout December. The yearly average was 6.03 cents, as compared to 6.25 cents in 1927.

The production of primary zinc in the United States amounted to 602,581 tons, as compared to 592,516 tons in 1927, production from domestic ores having increased 2.5 per cent, while that from foreign ores decreased 29 per cent. In 1928 electrolytic zinc amounted to nearly 27 per cent of the total production, as compared to 19 per cent in 1927. Coincident with this, Montana replaced Oklahoma as the leading producer of metallic zinc. The recovery of secondary zinc increased 7 per cent.

The apparent consumption of primary zinc in 1928 was a record for all time and was 12 per cent greater than in 1927. The brass industry showed the largest tonnage increase in the use of zinc, while die casting exhibited the largest percentage increase. Galvanizing used considerably more zinc in 1928, while rolled zinc showed a slight decrease.

¹ Work on manuscript completed October, 1929.

² The statistics in this report were prepared (unless otherwise indicated) by H. M. Meyer, and the data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the Bureau of Mines.

There was a 3 per cent decrease in mine production of recoverable zinc. The tri-State district (Joplin region) was responsible for all of the curtailment, producing 10 per cent less in 1928 than in 1927. The output of the Western States was virtually the same as in 1927, while in States east of the Mississippi River production increased 7 per cent.

World smelter production of zinc in 1928 amounted to 1,411,000 metric tons, an increase of 7 per cent over 1927. Substantial increases were made in practically all of the important producing countries, including Belgium, Poland, Germany, France, Canada, and Great Britain. Production in Australia and the Netherlands was about the same as in 1927. There were increases in many of the less important countries, including Japan, Mexico, Italy, and Czechoslovakia. In 1928 Northern Rhodesia for the first time became a substantial producer. Spain was the only country that showed a substantial decrease in 1928.

From reports of the many new mines developed during the past few years the world seems assured of an ample supply of zinc for many years to come. The application of selective flotation to previously unworkable complex ores and new discoveries now being rushed into production threaten to increase world production during the next few years at a rate considerably in excess of a reasonable expectation of increases in world consumption.

The zinc resources of the United States are believed to be ample to supply its needs for many years and to provide some export zinc, should the opportunity for export be presented. The present production in Mexico can probably be maintained or even increased, unless there should be a marked drop in price.

The output of metallic zinc in Canada may reasonably be expected to double within the next few years. In British Columbia the production of the Sullivan mine is being increased, and ore reserves are reported to be ample for many years of profitable operation. In addition, many large complex ore bodies containing zinc, lead, silver, and copper are being equipped for production. The Reeves-McDonald property is reported to have 2,000,000 tons of ore, containing 7 per cent of zinc. In Ontario the Errington and Sudbury Basin properties are believed to contain a few million tons of about 6 per cent zinc ore. Manitoba has two large and one smaller property. Flin Flon has developed 18,000,000 tons of 3.5 per cent zinc ore; Sheritt-Gordon is reported as being of the same order of magnitude as Flin Flon; and the Mandy mine has a reported reserve of 200,000 tons of 20 to 30 per cent zinc ore. In addition to the zinc all of these ore bodies contain substantial quantities of lead, silver, or copper. Under present plans, practically all of these mines will be brought into production within the next few years.

In Newfoundland, the Buchans mine, which has an ore reserve of 5,750,000 tons containing 17.85 per cent zinc, in addition to other values, is being equipped.

The Broken Hill district of Australia can probably continue present rate of production for about 10 years, according to published ore-reserve statements, and in addition the Mount Isa mine in Queensland is being equipped for production. This property has a reported reserve of 17,200,000 tons of sulphide ore containing 8.2 per cent zinc and 500,000 tons of a higher content, together with lead and silver in substantial quantities.

In Asia and Africa slow increases in production are expected, chiefly in Rhodesia, Siberia, and Indo-China. Increased production may also be expected in South America, where an electrolytic zinc plant will soon be built in Peru.

The future situation in Europe is somewhat obscured by opposing influences. Large ore bodies have been developed at Villemagne and St. Sebastien, in France, and mining activity in Russia appears to be awakening. Old plants are being remodeled and new plants are being erected, so that increased smelting capacity is to be expected. This appears to be consistent with the anticipated increase in ore production in other countries, some of which will undoubtedly be sent to Europe for smelting. Nevertheless early in 1928 the zinc producers in Europe, disturbed by the low price prevailing in the London market, formed a cartel to consider means of improving conditions. No positive action was taken during the year, but effective January 1, 1929, a 7 per cent curtailment of production was agreed upon. By October, 1929, curtailment had been increased to 10 per cent, but as yet it was questionable whether the cartel had benefited the industry.

PRODUCTION

GENERAL

The production of slab zinc is classified by the Bureau of Mines as (1) primary or secondary, according to whether the zinc has been manufactured from primary or secondary materials; (2) domestic or foreign, a division of primary production based on whether the materials used were domestic or foreign; (3) electrolytic or distilled, based on the process of manufacture.

To determine the production of primary zinc, the Bureau of Mines makes a canvass of the zinc smelters that ordinarily operate on primary raw materials of domestic and foreign origin. Many of these smelters also include substantial amounts of secondary materials in their furnace charges, so the slab zinc produced includes both primary and secondary zinc. Although the two are inseparable, the smelter calculates the amount of zinc produced from the secondary materials and classifies it as redistilled secondary zinc. A similar calculation is made in order to separate primary zinc into zinc of domestic and foreign origin.

The following table shows the quantity and value of domestic primary, foreign primary, and redistilled secondary zinc produced in the United States during the last 10 years:

Distilled and electrolytic zinc produced in the United States, 1919-1928

Year	Domestic primary		Foreign primary		Redistilled secondary		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	452,272	\$66,032,000	13,471	\$1,967,000	19,748	\$2,883,000	485,491	\$70,882,000
1920	450,045	72,907,000	13,332	2,160,000	21,371	3,462,000	484,748	78,529,000
1921	198,232	19,823,000	2,268	227,000	17,573	1,757,000	218,073	21,807,000
1922	353,274	40,273,000	1,003	114,000	32,988	3,761,000	387,265	44,148,000
1923	508,335	69,134,000	2,099	285,000	39,434	5,363,000	549,868	74,782,000
1924	515,831	67,038,000	1,508	196,000	35,489	1,613,000	552,825	71,867,000
1925	555,631	81,456,000	17,315	2,632,000	39,181	5,955,000	612,127	93,013,000
1926	611,991	91,799,000	6,431	964,000	40,799	6,120,000	659,221	98,883,000
1927	576,960	73,851,000	15,556	1,991,000	42,584	5,446,000	635,100	81,318,000
1928	591,525	72,166,000	11,056	1,319,000	48,666	5,937,000	651,247	79,452,000

PRIMARY ZINC

The term "primary zinc," as used herein, refers only to zinc produced from ores or from the immediate by-products of primary reduction operations. Thus, zinc manufactured from smelter drosses and skimmings is designated as primary, whereas that produced from galvanizers' drosses, ashes, and scrap metal is designated as secondary. Although a large part of the latter enters the market indistinguishable from the former and becomes part of the supply of zinc available to consumers, it is nevertheless deemed advisable to retain the above classification; otherwise the long-time record of production might include metal that is constantly reworked.

The following table shows the primary zinc produced in the United States from 1919 to 1928, apportioned according to the source of the ore and the locality at which it was reduced.

Primary zinc produced in the United States, 1919-1928, in short tons

APPORTIONED ACCORDING TO SOURCE OF ORE

Year	Domes- tic ¹	Foreign					Total
		Australia	Canada	Mexico	South America	Total	
1919-----	452,272	630	4,007	8,083	751	13,471	465,743
1920-----	450,045	2,235	1,583	8,978	536	13,332	463,377
1921-----	198,232	133	521	1,614	-----	2,268	200,500
1922-----	353,274	-----	55	948	-----	1,003	354,277
1923-----	508,335	-----	-----	2,099	-----	2,099	510,434
1924-----	515,831	-----	1,396	112	-----	1,508	517,339
1925-----	555,631	-----	7,997	9,318	-----	17,315	572,946
1926-----	611,991	-----	-----	6,431	-----	6,431	618,422
1927-----	576,960	-----	-----	15,556	-----	15,556	592,516
1928-----	591,525	-----	-----	11,056	-----	11,056	602,581

APPORTIONED ACCORDING TO LOCALITY AT WHICH REDUCED

Year	Arkansas	Idaho	Illinois	Kansas	Montana	Okla- homa	Pennsyl- vania	Other States	Total
1919-----	31,437	-----	118,458	43,942	24,255	121,988	67,521	58,142	465,743
1920-----	31,481	-----	109,056	41,044	50,017	110,500	74,234	47,045	463,377
1921-----	15,278	-----	48,865	16,573	11,559	41,244	36,378	30,603	200,500
1922-----	13,627	-----	76,266	24,167	55,369	74,537	57,319	52,992	354,277
1923-----	29,870	-----	93,239	32,006	71,088	119,744	82,003	82,484	510,434
1924-----	28,447	-----	93,370	28,640	77,493	118,487	83,016	87,886	517,339
1925-----	27,145	-----	109,672	25,765	79,004	138,906	99,899	92,555	572,946
1926-----	32,712	-----	110,381	33,671	111,596	136,560	100,538	92,964	618,422
1927-----	26,317	-----	102,768	33,144	112,629	120,801	106,099	90,758	592,516
1928-----	20,505	1,939	103,765	33,923	158,221	106,557	108,802	68,869	602,581

¹ The slab zinc that was rolled is included here.

The production of primary zinc in the United States in 1928 increased 10,065 tons, or 1.7 per cent over 1927. This resulted from an increase in production of 14,565 tons or 2.5 per cent from domestic ores and a decrease of 4,500 tons or 29 per cent in the production of primary zinc from foreign ores. As in 1926 and 1927, all of the foreign ore smelted in the United States in 1928 was imported from Mexico.

Montana became the leading producer of metallic zinc in 1928, with an output 40 per cent greater than in 1927, due to completion of the new electrolytic zinc plant of the Anaconda Copper Mining Co. at Anaconda, Mont., which is reported to have a maximum

capacity of 175 tons daily output. Pennsylvania ranked second, with a 2.5 per cent increase over 1927. Oklahoma, which for several years ranked first, ranked third in 1928 and produced 12 per cent less zinc than in 1927. The smelter production of Illinois and Kansas increased slightly in 1928, while the output of Arkansas decreased 22 per cent. Production of electrolytic zinc in Idaho began in the latter part of the year at the Kellogg plant of the Sullivan Mining Co. Other States in which zinc-smelting plants were operating in 1928 were West Virginia, Texas, and Indiana. West Virginia and Indiana showed substantial decreases and Texas a substantial increase.

The production of metallic zinc by the retort process decreased 8 per cent, while the production by the electrolytic process increased 42 per cent.

DISTILLED AND ELECTROLYTIC ZINC

As already stated, a considerable quantity of material designated as secondary zinc results from redistillation of zinc ashes and scrap; some smelters that handle ore regularly may at times smelt a mixture of secondary material and ore. In marketing slab zinc so produced it is not distinguished from primary metal. For statistical purposes, however, the amount of this secondary metal is calculated by the smelters and is recorded herein as redistilled secondary zinc.

Slab zinc produced for market is graded according to its purity. The official classification, as given by the American Society for Testing Materials, is shown below. The specifications of the United States Navy and War Departments are practically the same as those of the American Society for Testing Materials. Commercially, however, zinc is graded to narrower limits, and many companies market several varieties within the range of one official classification.

Classification of various grades of zinc and the maximum impurities allowed

Maximum impurities	Navy and War Departments				
	Grade A	Grade B	Grade C	Grade D	Grade E
	American Society for Testing Materials				
	High grade	Intermediate	Brass special	Selected	Prime western
Lead.....	<i>Per cent</i> 0.07	<i>Per cent</i> 0.20	<i>Per cent</i> 0.60	<i>Per cent</i> 0.80	<i>Per cent</i> 1.60
Iron.....	.03	.03	.03	.04	.08
Cadmium.....	.07	.50	.50	.75	(¹)
Aluminum.....	None.	None.	None.	None.	(¹)
Total.....	.10	.50	1.00	1.25	(¹)

¹ Not specified.

In segregating production into the various grades the smelters report the total production and do not differentiate between primary distilled and redistilled secondary. The following table shows the total production of electrolytic and distilled zinc, both primary and secondary, apportioned according to method of reduction and according to grade:

Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1919-1928, in short tons

APPORTIONED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic	Distilled primary	Redistilled secondary ¹	Total
1919.....	27,056	438,687	19,748	485,491
1920.....	51,626	411,751	21,371	484,748
1921.....	11,559	188,941	17,573	218,073
1922.....	55,369	298,908	32,988	387,265
1923.....	71,088	439,346	39,434	549,868
1924.....	77,493	439,846	35,486	552,825
1925.....	79,004	493,942	39,181	612,127
1926.....	111,596	506,826	40,799	659,221
1927.....	112,629	479,887	42,784	635,300
1928.....	160,160	442,421	48,666	651,247

APPORTIONED ACCORDING TO GRADE

Year	Grade A (high grade)	Grade B (intermediate)	Grade C (brass special)	Grade D (selected)	Grade E (prime western)	Total
1919.....	45,377	39,173	140,917		260,024	485,491
1920.....	80,713	33,893	59,811		310,331	484,748
1921.....	24,084	4,996	47,814		141,179	218,073
1922.....	67,459	36,402	49,980		233,424	387,265
1923.....	89,739	58,513	90,459		311,157	549,868
1924.....	108,238	48,874	100,290		295,423	552,825
1925.....	111,964	49,198	81,176		369,789	612,127
1926.....	143,224	48,169	84,689		383,139	659,221
1927.....	150,933	40,121	72,104		372,142	635,300
1928.....	197,675	41,779	73,957		337,836	651,247

¹ For total production of secondary zinc see p. 373.

The table shows the marked increase in the production of electrolytic zinc in 1928 as reflected in the increased production of high-grade metal. Coincidentally there was a substantial decrease in the production of distilled primary zinc and prime western grade of metal. The production of redistilled secondary zinc increased 14 per cent.

HIGH GRADE

The production of high-grade metal, formerly used chiefly in the manufacture of die-casting alloys and special brasses, has so expanded as a result of the increased application of the electrolytic process that the supply far exceeds ordinary demands, and much of it is now being used in the manufacture of ordinary brass. The result has been a reduction in the premium paid for high-grade zinc. In 1914, when no electrolytic zinc was produced, the production of high-grade metal amounted to 5 per cent of the total output, and a premium of 3 cents a pound was paid. During the World War the premium increased to several times that amount, but in recent years it has decreased steadily. In 1928, 30 per cent of the total zinc produced was high grade, and the average premium based on prices quoted by the American Metal Market was only 1.4 cents a pound. The reduction of premium continued throughout 1928. In January high-grade metal was quoted at $1\frac{3}{4}$ cents above prime western, but by December the differential had been reduced to about 1 cent.

During the year an unusual zinc product was introduced to the market under the trade name of "Bunker Hill" zinc. This product is produced by the Sullivan Mining Co., which operates an electro-

lytic plant, using the Tainton process, at Kellogg, Idaho. It is claimed that this zinc is 99.99 per cent pure and has many remarkable properties that will extend the use of zinc into new fields. It is being marketed in New York at a premium of $1\frac{1}{4}$ cents above the St. Louis quotation for prime western grade.

INTERMEDIATE

The intermediate grade of zinc is practically all used in the manufacture of specialty alloys and brasses and is becoming of less importance. In 1923 nearly 59,000 tons was produced, but in 1928 production decreased to less than 42,000 tons. This grade of zinc commands a premium of about one-half cent a pound over prime western.

BRASS SPECIAL

Brass special, as its name suggests, is largely used in the manufacture of brass. During the last few years the relative importance of this grade has decreased on account of the tendency of brass manufacturers to use increasing amounts of high-grade zinc. The production of brass special, including a small tonnage of selected grade, decreased from 100,000 tons in 1924 to 74,000 tons in 1928. The 1924 output was equivalent to 65 per cent of the total zinc used in the manufacture of brass, while the 1928 output was equivalent to only 41 per cent of the total, roughly indicating the extent to which high-grade zinc is replacing brass special in this field. The premium on this grade in 1928 ranged from 0.05 to 0.15 cent per pound.

SELECTED

Only a relatively small quantity of the selected grade of zinc is produced, and the tonnage is included with the production of brass special. It is used chiefly in the manufacture of cheaper brasses where uniformity of composition is necessary, such as in brass rod stock for machine-made screws, bolts, tire valves, etc. The narrower limits of composition of this grade of zinc permit a closer control on the machining properties of the brass product than could be obtained with prime western zinc. The premium on this grade is about 5 cents per 100 pounds.

PRIME WESTERN

Prime western zinc is the most common grade and is the principal product of retort smelters. In 1925 this grade amounted to 60 per cent of the total output but in 1928 had decreased to 52 per cent. It is estimated that approximately three-fourths of the production of this grade of zinc is used in the zinc-coating (galvanizing) industry. Prime western zinc is also used in the manufacture of cheaper grades of brass.

ROLLED ZINC

The accompanying tables show the quantity and value of rolled zinc produced in the United States from 1919 to 1928. The total production in 1928 amounted to 73,531 tons, or 1 per cent less than the 1927 output and 15 per cent less than that in 1926. The largest part of the decrease during the last two years may be attributed to the decline in the manufacture of dry cells that has resulted from the widespread adoption of "socket-power" radio receivers. According to the

American Bureau of Metal Statistics the consumption of rolled zinc in the manufacture of dry batteries decreased from 28,350 tons in 1926 to 17,589 tons in 1928, a drop of 38 per cent. The total value of the rolled zinc produced in 1928 was 10 per cent less than in 1927 and 31 per cent less than in 1926.

Imports of sheet zinc into the United States since 1923 have been negligible. Exports in 1928 increased 10 per cent over 1927 and amounted to 6 per cent of the total United States production.

Zinc rolled in the United States, 1919-1928

Year	Pounds	Value		Year	Pounds	Value	
		Total	Average			Total	Average
1919-----	108,593,747	\$11,447,569	\$0.105	1924-----	122,064,719	\$11,552,354	\$0.095
1920-----	106,467,530	12,290,233	.115	1925-----	142,263,945	14,514,234	.102
1921-----	60,800,186	5,940,208	.098	1926-----	172,668,298	17,880,901	.104
1922-----	107,018,690	8,546,109	.080	1927-----	148,259,718	13,671,530	.092
1923-----	111,666,474	10,164,981	.091	1928-----	147,061,670	12,364,908	.084

Rolled zinc available for consumption in the United States, 1927-28

	1927			1928		
	Pounds	Value		Pounds	Value	
		Total	Average		Total	Average
Sheet zinc not over 0.1 inch thick-----	49,371,015	\$4,713,995	\$0.095	52,082,442	\$4,606,138	\$0.088
Boiler plate and sheets over 0.1 inch thick-----	4,180,253	364,770	.087	3,833,523	309,531	.081
Strip and ribbon zinc-----	94,708,450	8,592,765	.091	91,145,705	7,449,239	.082
Total zinc rolled-----	148,259,718	13,671,530	.092	147,061,670	12,364,908	.084
Sheet zinc imported for consumption-----	1,901	271	.143	6,904	2,556	.370
Rolled zinc exported-----	7,844,757	869,425	.111	8,649,712	906,515	.105
Available for consumption-----	140,416,862			138,418,862		
Slab zinc, grades B and C-----			.065			.061
Spread-----			.027			.023

The quoted base price of sheet zinc, carload lots, f. o. b. rolling mills, ranged from 8½ to 10 cents per pound during 1928. These quotations, however, are subject to discounts, which may fluctuate, whereas the base quotations remain steady. The average price actually received by rolling mills reporting to the Bureau of Mines was 8.4 cents for all classes of rolled zinc, compared with 9.2 cents in 1927, a drop of 9 per cent. The average price of the grades of slab zinc used in rolling mills decreased to 6.1 cents, so that the value added by rolling amounted to only 2.3 cents per pound in 1928, as compared with 2.7 cents in 1927 and 2.8 cents in 1926.

The following companies reported production of rolled zinc in the United States in 1928:

Producers of rolled zinc in the United States in 1928

	Location of plant
American Zinc Products Co.....	Greencastle, Ind.
Ball Bros. Co.....	Muncie, Ind.
Edes Manufacturing Co.....	Plymouth, Mass.
Hazel-Atlas Glass Co.....	Wheeling, W. Va.
Hegeler Zinc Co.....	Danville, Ill.
Illinois Zinc Co.....	Peru, Ill.
Matthiessen & Hegeler Zinc Co.....	La Salle, Ill.
New Jersey Zinc Co.....	Palmerton, Pa.
The Platt Bros. & Co.....	Waterbury, Conn.

ZINC DUST

The commercial production of zinc dust in the United States began in 1910 and reached a maximum in 1920, when it amounted to approximately 11,500 tons. From 1922 to 1927 the annual production averaged about 8,000 tons. In 1928, 9,172 tons was produced, an increase of 13 per cent over 1927.

Zinc dust varies in composition but on the average contains about 90 per cent of metallic zinc and 10 per cent of zinc oxide, the latter occurring as a film on the surface of the metallic particles. Before 1926 two varieties of zinc dust—"blue powder" and "atomized"—were marketed; the former was produced by the distillation of zinc and the latter by ejecting molten metal from a nozzle under pressure. No atomized zinc dust was sold in 1926 or 1927, but in 1928 production of the commodity for market was resumed by The Alloys Co., of San Francisco, Calif. The Anaconda Copper Mining Co. and the Sullivan Mining Co. produce some atomized zinc dust, but since their entire product is used as a purifying agent in their electrolytic zinc plants and eventually enters the market as slab zinc, it is not included in the figures given in the following table.

Zinc dust sold by producers in the United States, 1919-1928

Year	Prepared "blue powder"			Zinc dust "atomized"			Primary zinc recovered as zinc dust (short tons) ¹
	Short tons	Value		Short tons	Value		
		Total	Average per pound		Total	Average per pound	
1919.....	4,083	\$801,366	\$0.098	2,715	\$566,294	\$0.104	3,430
1920.....	9,066	2,009,117	.111	2,463	555,773	.113	6,425
1921.....	2,006	333,390	.083	999	152,151	.076	1,380
1922.....	3,394	531,225	.078	3,859	573,220	.074	2,113
1923.....	3,676	643,766	.088	4,376	702,923	.080	2,450
1924.....	3,894	620,078	.080	4,063	621,221	.076	1,861
1925.....	² 8,314	² 1,500,758	² .090	(²)	(²)	(²)	2,251
1926.....	7,994	1,490,293	.093	-----	-----	-----	2,794
1927.....	8,098	1,345,105	.083	-----	-----	-----	3,249
1928.....	² 9,172	² 1,475,875	² .080	(²)	(²)	(²)	2,668

¹ The amount of secondary zinc recovered in zinc dust, 1925-1928, is shown in the table on secondary zinc, p. 373.

² Figures for "atomized" included under "blue powder." Bureau of Mines not at liberty to publish figures separately.

One of the chief uses of zinc dust is in the sherardizing process, wherein metal articles are given a zinc coating by heating with zinc dust in a sealed container. It is said that the zinc vaporizes at a tem-

perature below its melting point and that the vapor forms an alloy on the surface of the metals to be coated. The process is especially adapted to the coating of quantities of small articles and threaded hardware, such as screws, bolts, and nuts. Zinc dust is also used as a reducing agent in the manufacture of dyes, as a precipitant of gold in the cyanide process, and as a pigment in paints, especially marine paints.

The following companies reported the production and sale of zinc dust in 1928:

Producers of zinc dust in the United States in 1928

	Location of plant
The Alloys Co.....	San Francisco, Calif.
Federated Metals Corporation.....	Trenton, N. J.
John Finn Metals Works.....	San Francisco, Calif.
Grasselli Chemical Co.....	Meadowbrook, W. Va.
New Jersey Zinc Co.....	Palmerton, Pa.
Superior Zinc Corporation.....	Philadelphia, Pa.
United States Zinc Co.....	Sand Springs, Okla.

ZINC PIGMENTS AND SALTS

Zinc oxide, leaded zinc oxide, and lithopone are the principal pigments of zinc, and the chloride and sulphate are the principal salts. These products are manufactured from various zinciferous materials, such as ores, metal, and secondary substances. In 1928 the total zinc content of all zinc pigments and salts produced and sold amounted to 187,031 tons, an increase of 4 per cent over 1927. This was derived from the following sources:

	Short tons
Domestic ores.....	124, 090
Metal.....	37, 588
Secondary material.....	25, 353

The following table gives the primary zinc content (that is, zinc derived directly from ores) of zinc pigments and salts produced for market in the United States during the last 10 years.

Primary zinc content of zinc pigments and salts made in the United States, 1919–1928, in short tons¹

Year	Pigments	Salts	Year	Pigments	Salts
1919.....	96, 817	3, 393	1924.....	108, 282	1, 075
1920.....	110, 695	6, 284	1925.....	110, 554	673
1921.....	53, 480	3, 749	1926.....	127, 685	2, 106
1922.....	93, 112	1, 801	1927.....	121, 899	47
1923.....	115, 970	1, 573	1928.....	123, 964	126

¹ Includes some zinc derived from primary drosses from zinc-reduction plants.

The direct use of zinc ore in the manufacture of pigments and salts increased 2 per cent in 1928, while the use of metallic zinc and secondary material increased 11 and 8 per cent, respectively.

Ore was used in the following products in 1928; the percentages represent proportion of the total zinc, recoverable from the ore, entering the various pigments:

	Per cent
American process zinc oxide.....	70
Lithopone.....	21
Leaded zinc oxide.....	9

The metallic zinc was practically all used in the manufacture of French process zinc oxide. The secondary zinc was distributed as follows:

	Per cent
Lithopone.....	48
Zinc salts.....	41
Leaded zinc oxide.....	11

Further details of the production of zinc pigments and salts are given in the Mineral Resources chapter on lead and zinc pigments.

SECONDARY ZINC

The accompanying table shows the amount of secondary zinc recovered in the United States as metal and in zinc dust, zinc pigments, and zinc salts, 1925 to 1928.

Secondary zinc recovered in the United States, 1925-1928, in short tons

	1925	1926	1927	1928
Secondary zinc, redistilled.....	39,181	40,799	42,784	48,666
Secondary zinc, remelted.....	22,249	23,771	22,016	22,034
Total zinc recovered unalloyed.....	61,430	64,570	64,800	70,700
Recovered zinc in alloys, excluding old brass remelted.....	13,300	13,430	12,400	12,500
Recovered zinc in remelted brass (estimated).....	53,300	63,000	63,200	66,000
Secondary zinc recovered as metal.....	128,000	141,000	140,400	149,200
Secondary zinc recovered in zinc dust.....	5,232	4,400	4,400	5,600
Secondary zinc recovered in pigments.....	11,714	12,480	14,000	14,900
Secondary zinc recovered in zinc salts.....	10,928	10,084	9,544	10,500
Total secondary zinc.....	156,000	168,000	168,300	180,200

The recovery of secondary zinc increased 7 per cent in 1928 and exceeded all previous records. The production of primary zinc increased only 2 per cent.

Secondary zinc recovered in the form of metal increased 6 per cent, due to increases of 14 per cent in redistilled secondary zinc and 4 per cent in remelted brass. That recovered in dust, pigments, and salts increased 11 per cent, all three products having contributed substantially to the increase.

Since 1910, the first year for which satisfactory data are available, production of secondary zinc has increased steadily, except during the postwar period. Since the production of primary zinc has increased at about the same rate, however, there has been little change in the ratio of secondary to primary zinc. From 1910 to 1914 the recovery of secondary zinc as metal was equivalent to 23 per cent of the primary zinc output. During the war and postwar periods the ratio was upset by extraordinary conditions, but during the last five years it has averaged 24 per cent. In 1928 the ratio was 25 per cent. Similar ratios for copper and lead were 43 and 40 per cent, respectively. This relatively advantageous position of zinc is probably due to the large percentage consumed in dissipative uses, such as zinc coatings, zinc dust, pigments, and salts which yield little secondary metal. It is estimated that less than 35 per cent of all the zinc mined each year is ever available for secondary usage.

BY-PRODUCT SULPHURIC ACID

An important by-product of zinc-smelting operations is the sulphuric acid made from the sulphur gases evolved in roasting zinc sulphide ores preparatory to their reduction to metal or conversion to zinc oxide or to zinc salts. Sulphur gases from zinc ores were first thus utilized, in the United States at least, by Matthiessen & Hegeler at La Salle, Ill., in 1882; but now these gases are used at numerous acid plants, which may be at zinc smelters and zinc oxide plants, at roasting and magnetic separating plants, at the mines, or nearer the acid markets, the roasted concentrates being shipped to the smelters or to other zinc plants.

For several years the demand for sulphuric acid has been strong, and in order to utilize their acid-plant capacities producers have been forced to burn large quantities of sulphur to supplement the gases derived from the roasting of zinc blende; thus the acid production recorded as a by-product of zinc smelting has been derived from two sources—zinc ores and sulphur.

The following table gives the total quantity and value of sulphuric acid of different strengths produced and sold by plants associated with zinc-blende roasting operations:

By-product sulphuric acid produced at zinc-blende roasting plants in the United States, 1925-1928

	1925	1926	1927	1928
Number of establishments.....	22	22	22	21
Acid reported as 50°-60° B.:.....				
Produced (expressed as 60° B.).....short tons..	616, 171	647, 380	605, 086	643, 407
Consumed at works (expressed as 60° B.).....do....	31, 902	37, 555	34, 586	32, 680
Sold (expressed as 60° B.).....do.....	599, 729	615, 356	572, 347	618, 010
Value of acid sold—				
Total.....	\$5, 175, 994	\$5, 839, 666	\$5, 588, 204	\$6, 109, 459
Average.....	\$8. 63	\$9. 49	\$9. 76	\$9. 89
Acid reported as 66° B. and stronger:				
Produced (expressed as 66° B.).....short tons..	388, 699	401, 841	401, 290	384, 445
Consumed at works (expressed as 66° B.).....do....	46, 781	50, 412	48, 637	34, 742
Sold (expressed as 66° B.).....do.....	369, 974	364, 706	334, 470	365, 596
Value of acid sold—				
Total.....	\$4, 918, 716	\$4, 935, 104	\$4, 752, 736	\$5, 077, 475
Average.....	\$13. 29	\$13. 53	\$14. 21	\$13. 89
Total acid sold, equivalent in 60° B.:.....				
Quantity.....short tons..	1, 043, 697	1, 053, 003	973, 711	1, 056, 725
Value.....	\$10, 094, 710	\$10, 774, 770	\$10, 340, 940	\$11, 186, 934
Total acid consumed at works (60° B.).....short tons..	88, 039	98, 049	92, 950	74, 370

The total production of sulphuric acid (60° B.) at zinc-blende roasting plants in 1928 amounted to 1,104,741 tons, an increase of 1 per cent over 1927 and about 19 per cent of the total output of sulphuric acid in the United States, as estimated by Chemical and Metallurgical Engineering.³

The quantity of acid sold by zinc plants in 1928 exceeded that for 1927 by 8.5 per cent. The average price received per ton of 60° B. acid increased slightly in 1928, but owing to a greater decrease in the price of 66° B. and stronger acids there was a slight decrease in the average price of all by-product acid marketed in 1928. The total value of sales increased 8.2 per cent in 1928. Sales of 60° B. acid increased 8 per cent, while production increased 6 per cent. Sales of

³ Chemical and Metallurgical Engineering, January, 1929, p. 31. Estimated production for 1928 was 7,225,000 tons of 50° B. acid, equivalent to 5,784,000 tons of 60° B. acid.

66° B. acid increased 9 per cent, while production decreased 4 per cent. Statistics indicate that producers' stocks of both grades of acid were reduced substantially in 1928.

The following statement shows the quantity of blende and sulphur used and the production and value of the acid made from each:

Production and value of sulphuric acid made from blende and sulphur at zinc-blende roasting plants in the United States in 1928

Number of establishments.....	21
Blende used.....short tons.....	621, 158
Acid made, equivalent in 60° B.....do.....	558, 537
Value at \$9.89 per ton (average of sales of 60° B.).....	\$5, 523, 931
Sulphur used.....short tons.....	147, 026
Acid made, equivalent in 60° B.....do.....	546, 204
Value at \$9.89 per ton (average of sales of 60° B.).....	\$5, 401, 958
Total quantity of acid made (60° B.).....short tons.....	1, 104, 741
Total value of acid made.....	\$10, 925, 889

In 1928, 51 per cent of the acid made at zinc plants was derived from blende and 49 per cent from sulphur, as compared with 54 and 46 per cent, respectively, in 1927. There was 1 per cent less blende used and 5 per cent less acid made from blende in 1928 than in 1927. Acid made from blende was equivalent to 10 per cent of the total production of the United States. The quantity of sulphur used at zinc plants in 1928 increased 10 per cent, and the acid produced therefrom increased 9 per cent.

A list of the operators and the location of acid plants whose outputs in the years 1925 to 1928 are shown in the preceding tables follows. Plants at zinc smelters are also indicated in the list of zinc-reduction plants given on page 378. The American Zinc Oxide Co., of Columbus, Ohio, has a zinc-roasting plant and disposes of the sulphur gases to the neighboring plant of the Farmers Fertilizer Co.

Producers of by-product sulphuric acid at zinc-blende roasting plants in the United States, 1925-1928

	Location of plant
American Steel & Wire Co.....	Donora, Pa.
American Zinc & Chemical Co.....	Langeloth, Pa.
American Zinc Co. of Illinois.....	East St. Louis, Ill.
Do.....	Hillsboro, Ill.
American Zinc Oxide Co.....	Columbus, Ohio.
Eagle-Picher Lead Co.....	Hillsboro, Ill.
Grasselli Chemical Co.....	Grasselli, Ind.
Do.....	Canton, Ohio.
Do.....	Cleveland, Ohio.
Do.....	Lockland, Ohio.
Do.....	Niles, Ohio.
Do.....	New Castle, Pa.
Hegeler Zinc Co.....	Danville, Ill.
Illinois Zinc Co.....	Peru, Ill.
Matthiessen & Hegeler Zinc Co.....	La Salle, Ill.
Mineral Point Zinc Co.....	Depue, Ill.
Do.....	Mineral Point, Wis.
National Zinc Co. ⁴	Bartlesville, Okla.
National Zinc Separating Co.....	Platteville, Wis.
New Jersey Zinc Co. (of Pennsylvania).....	Palmerton, Pa.
United Zinc Smelting Corporation.....	Moundsville, W. Va.

⁴ Started operation in 1928.

Early in the year the new contact plant of the National Zinc Co. at Bartlesville, Okla., began operations. According to early press notices the capacity of the plant was to be 4,500 tons of high-grade acid per month in 1928, and an ultimate capacity between 6,000 and 7,000 tons was contemplated. This plant replaced the former brimstone plant of the company at Argentine, Kans., which was abandoned at the end of 1927. The American Zinc, Lead & Smelting Co. made extensive improvements at its East St. Louis by-product acid plant. Six Mills Packard towers, ammonia oxidation machines, a new Glover tower, an enlarged Gay-Lussac tower, and two new Herreshof roasters were put into operation, and much old equipment was replaced with modern installations. The capacity of the plant was increased substantially.

The use of vanadium catalysts in the contact process is said to be especially effective in by-product acid plants where the danger of fouling impurities in roaster gases is ever present. It is claimed that the new catalysts are not affected by many of the impurities that quickly poison platinum catalysts. Some by-product acid plants are now using vanadium catalysts.

MINE PRODUCTION

The following table shows the mine production of zinc in the United States, by States, during the past 10 years.

Mine production of recoverable zinc in the United States, 1919-1928, in short tons

State	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Arizona	859	729	-----	105	260	-----	3,666	6,473	1,134	639
Arkansas	189	329	15	134	148	4	43	87	128	86
California	236	583	423	1,506	-----	1,530	5,745	10,217	4,031	-----
Colorado	18,610	24,395	1,180	11,629	27,076	28,364	30,811	32,500	35,865	35,731
Idaho	7,997	13,966	17	2,055	13,976	7,670	15,619	26,307	26,778	31,263
Illinois	6,788	4,720	2,426	3,124	1,266	2,512	2,724	2,577	621	17
Kansas	47,636	61,073	36,994	56,225	100,969	105,392	118,778	126,307	109,427	107,251
Kentucky	36	9	220	142	270	492	429	1,838	860	92
Missouri	31,540	24,509	10,845	16,171	18,265	12,920	14,794	26,018	18,737	12,974
Montana	84,382	92,169	11,638	59,535	70,730	64,238	57,658	73,701	80,231	82,830
Nevada	4,502	5,349	35	1,309	7,083	5,501	7,411	5,409	3,172	3,398
New Jersey	92,516	78,511	56,447	73,657	75,227	84,370	89,261	80,629	95,695	99,871
New Mexico	3,797	5,007	114	2,248	8,248	10,380	9,246	12,052	29,802	31,203
New York	5,120	5,654	1,572	4,816	8,463	4,664	5,158	5,041	3,750	11,257
Oklahoma	178,410	219,727	121,372	209,682	242,421	269,137	283,371	272,567	206,611	180,252
Tennessee	23,247	19,217	9,692	15,568	15,900	14,376	16,256	12,098	10,400	132,917
Utah	2,216	4,079	35	2,560	5,665	9,281	26,306	47,590	49,593	46,929
Virginia	-----	-----	-----	-----	-----	2,664	2,732	5,830	8,325	(1)
Washington	-----	213	225	614	1,612	455	609	522	640	43
Wisconsin	40,765	27,285	3,390	10,952	13,211	14,027	20,230	26,800	32,841	18,417
	548,846	587,524	256,640	472,032	610,690	637,977	710,847	774,563	718,541	695,170

¹ Bureau of Mines not at liberty to publish figures for Virginia for 1928. These figures are included in the total for Tennessee.

The mine production of recoverable zinc in 1928 was 23,371 tons (3 per cent) less than in 1927, while the smelter production of primary zinc increased about 2 per cent. As in 1927 the tri-State (Joplin) district was responsible for all of the curtailment. The 1928 output of this district was about 297,000 tons, as compared with 331,000 tons in 1927, a drop of 10 per cent. In 1928 the output was 43 per cent of the United States total; in 1927 it was 46 per cent. Stocks of ore (concentrates) in the tri-State district, as reported by the American Bureau of Metal Statistics, were 37,760 tons at the end of 1928, as

compared to 45,920 tons at the end of 1927. Oklahoma and Kansas retained their position as the leading sources of zinc in the United States.

Outside of the tri-State district the Western States are the most important source of zinc. This group produced 232,000 tons of recoverable zinc, or 33 per cent of the country's total, in 1928, as compared to 231,000 tons, or 32 per cent in 1927. The five principal producers in 1928 and the part contributed to the Western States output were Montana 36 per cent, Utah 20 per cent, Colorado 15 per cent, and Idaho and New Mexico 13 per cent each. Nevada, Arizona, and Washington produced the remainder. Montana, Idaho, New Mexico, and Nevada increased outputs in 1928; the others showed decreases. California failed to produce in 1928; in 1927 its output was 4,031 tons.

East of the Mississippi River New Jersey is by far the most important source of zinc and ranks third in the country's total; production increased 4 per cent in 1928. The combined output of Virginia and Tennessee increased 76 per cent in 1928. The principal increase was in Virginia. New York tripled its production in 1928 as a result of operations at Edwards under the auspices of the St. Joseph Lead Co. Production in Wisconsin decreased 44 per cent. The New Jersey Zinc Co. has suspended operations in the Platteville district, so that the Vinegar Hill Zinc Co. is now the only important producer in the district.

Detailed information concerning the mining activities in the various districts of the United States can be found in the chapters of this series dealing with the mine production of gold, silver, copper, lead, and zinc in the various States.

FLOTATION CONCENTRATES

The widespread adoption of selective flotation in the United States since 1921 is well illustrated in the following table, which shows the production of zinc flotation concentrates, exclusive of the tri-State district, from 1921 to 1928:

*Zinc flotation concentrates produced in the United States, exclusive of the tri-State district, 1921-1928*¹

Year	Concentrates (short tons)	Zinc content		Lead content	
		Short tons	Tenor, per cent	Short tons	Tenor, per cent
1921	38,433	15,311	39.84	4,457	11.60
1922	82,121	37,116	45.20	6,105	7.43
1923	169,496	83,778	49.42	11,181	6.60
1924	227,955	109,005	47.82	14,368	6.30
1925	253,989	130,594	51.42	11,954	4.36
1926	404,485	208,834	51.63	16,722	4.13
1927	500,675	265,702	53.07	12,298	2.46
1928	551,187	294,522	53.43	17,267	3.13

¹ Year Book, American Bureau of Metal Statistics, 1928.

ZINC-REDUCTION PLANTS

ZINC SMELTERS

The number of retorts at zinc smelters active in 1928 was 9 per cent less and the output of smelted primary zinc was 8 per cent less than in 1927. Some time during the year 21 smelters containing 107,528 retorts were active, whereas in 1927 there were 24 active plants with 118,458 retorts. The United States Zinc Co. plant at Henryetta, Okla., was shut down in July, 1928, and has since been abandoned. The smelter of the Quinton Spelter Co. was idle at the end of the year. The Clarksburg plant of the Grasselli Chemical Co. and the plant of the Falcon Zinc Co., both of which shut down in 1927, were also idle throughout 1928. The companies did not report the constructing of any new retorts or plants for doing so in 1928.

At the end of the year 19 smelters were in operation, using 63,716 retorts, or about 60 per cent of the available retorts in these plants. On December 31, 1927, 77,388 retorts were in use.

The following table shows the zinc-smelting plants operating in the United States in 1928:

Zinc-smelting plants operating in the United States in 1928

Operating company (A=acid plant located at the smelter)	Location of plant	Retorts
ARKANSAS		
Athletic Mining & Smelting Co.-----	Fort Smith-----	3,328
ILLINOIS		
American Zinc Co. of Illinois (A)-----	East St. Louis-----	5,760
Hegeler Zinc Co. (A)-----	Danville-----	5,400
Illinois Zinc Co. (A)-----	Peru-----	4,400
Matthiessen & Hegeler Zinc Co. (A)-----	La Salle-----	6,132
Mineral Point Zinc Co. (A)-----	Depue-----	9,068
Missouri Zinc Co.-----	Beckemeyer-----	608
INDIANA		
Grasselli Chemical Co.-----	Terre Haute-----	4,200
KANSAS		
Edgar Zinc Co.-----	Cherryvale-----	5,160
Weir Smelting Co.-----	Caney-----	1,920
OKLAHOMA		
Blackwell Zinc Co. (Inc.)-----	Blackwell-----	9,600
Eagle-Picher Lead Co.-----	Henryetta-----	4,800
National Zinc Co. (A)-----	Bartlesville-----	4,256
Quinton Spelter Co.-----	Quinton-----	3,360
United States Zinc Co.-----	Henryetta-----	3,200
PENNSYLVANIA		
American Steel & Wire Co. (A)-----	Donora-----	7,904
American Zinc & Chemical Co. (A)-----	Langeloth-----	4,864
New Jersey Zinc Co. (of Pennsylvania) (A)-----	Palmerton-----	7,200
TEXAS		
United States Zinc Co.-----	Amarillo-----	5,600
WEST VIRGINIA		
Grasselli Chemical Co.-----	Meadowbrook-----	8,400
United Zinc Smelting Corporation (A)-----	Moundsville-----	2,368
		107,528

In addition to these smelters the following operators treated secondary materials in large graphite retorts in 1928:

Birmingham Smelting & Refining Co., Birmingham, Ala.
 General Smelting Co., Philadelphia, Pa.
 Superior Zinc Corporation, Philadelphia, Pa.
 Tottenville Copper Co., Tottenville, N. Y.
 Trenton Smelting & Refining Branch of Federated Metals Corporation, Trenton, N. J.
 Wheeling Steel Corporation, Wheeling, W. Va.

ELECTROLYTIC PLANTS

Two new electrolytic zinc plants came into production in 1928. The Anaconda (Mont.) plant of the Anaconda Copper Mining Co. began production in January, and the plant of the Sullivan Mining Co. at Kellogg, Idaho, began production of metal in October. The Great Falls plant of the Anaconda Co., which was built in 1916 and subsequently enlarged, operated throughout 1928. In October the Evans-Wallower Zinc Co. began construction of a new electrolytic zinc plant at East St. Louis, Ill. When this plant is completed the total daily capacity of electrolytic zinc plants will be about 638 tons, or the equivalent of 40 per cent of the average daily output of primary zinc in 1928. The electrolytic zinc produced in 1928 was 27 per cent of the total primary zinc output.

The following table summarizes data on the electrolytic zinc plants in the United States:

Electrolytic zinc plants in operation and under construction in the United States in 1928

Company	Location	Year completed	Number of cells	Maximum daily capacity in short tons of refined zinc
Anaconda Copper Mining Co.....	Great Falls, Mont.....	1916 and later enlarged.	1,164	350
Do.....	Anaconda, Mont.....	1928.....	576	175
Sullivan Mining Co.....	Kellogg, Idaho.....	1928.....	300	60
Evans-Wallower Zinc Co.....	East St. Louis, Ill.....	Under construction	190	53

Two processes for making electrolytic zinc have been developed commercially in the United States. The first was developed by the Anaconda Copper Mining Co., and the first large installation was made at Great Falls, Mont., in 1916. The second process, known as the Tainton, was first used commercially in the Sullivan plant in Idaho.

Both processes follow the same general procedure. Zinc-bearing material is subjected to a roast, which converts the zinc minerals to the soluble oxide and sulphate. The calcine is treated with sulphuric acid solution, which dissolves out the zinc content. The zinc-bearing solution is then purified and the zinc precipitated electrolytically.

The essential differences in the two processes are in the strength of acid used in the leach and the current density at which electrodeposition is carried on. The Tainton process uses stronger acid and a higher current density than the Anaconda.

The two processes can be briefly described as follows:

ANACONDA PROCESS ⁵

In roasting zinc concentrates containing iron some of the zinc combines with iron to form a zinc ferrate, which is insoluble in dilute sulphuric acid. As an acid of 10 to 15 per cent strength is used in this process, the roasting operation must be carefully conducted to produce a minimum of zinc ferrate. This is accomplished by careful control of temperatures within the roaster. Dust and fume produced in this operation are recovered in Cottrell plants and returned to the circuit. The calcine is leached by a continuous process. It is first subjected to a "neutral" leach, wherein a large excess of zinc oxide is provided to insure a neutral solution. Manganese dioxide is added to oxidize all the iron, which in the presence of an excess of zinc oxide precipitates out as ferric hydroxide. Arsenic and antimony form insoluble salts with ferric hydroxide and are completely removed from the solution. Filtration of this pulp yields (1) a neutral solution free of iron, arsenic, and antimony but containing copper and cadmium as the principal impurities, and (2) a residue containing appreciable amounts of zinc, which is given further treatment. The copper and cadmium are precipitated from the neutral solution by agitation with an excess of zinc dust. This operation is carried out in batches, and the purified solution is sent to the tank house for further treatment. The zinc-copper-cadmium sludge is roasted and leached with sulphuric acid. The copper is removed from the resultant solution by precipitation on metallic zinc and the cadmium by electrolysis; the final liquor containing only zinc is returned to the main leaching plant.

Each cell in the tank house contains 28 chemical lead anodes and 27 pure aluminum cathodes. The zinc-bearing neutral solution enters the tank house containing about 110 grams of zinc per liter and discharges with about 105 grams of sulphuric acid per liter. The zinc is deposited on both sides of the cathodes and is removed every 24 hours, melted, and cast into slabs for market. Precipitation is conducted at a current density of 30 amperes per square foot of cathode area. Manganese dioxide separates out at the anode and falls to the bottom of the tank, whence it is removed periodically and returned to the leaching plant.

The residue from the neutral leach containing both soluble and insoluble zinc salts is given an acid leach with spent electrolyte. An excess of acid is provided to insure complete solution of all soluble zinc. The liquor from this leach is returned to and becomes part of the solution used in the first or neutral leach. The residue containing the insoluble zinc ferrate is dried, mixed with concentrated sulphuric acid to form a mud, and roasted. This treatment yields soluble zinc, iron, and copper sulphates, which are extracted with water. This solution is returned to the purification system and the residue from the water leach, which contains most of the lead and silver in the original ore, is shipped to a lead smelter.

⁵ Laist, F., Frick, F. F., Elton, J. O., and Caples, R. B., *Electrolytic Zinc Plant of Anaconda Copper Mining Co., at Great Falls, Mont.*: Trans. Am. Inst. Min. Eng., vol. 64, 1920, p. 699.
Wiggin, A. E., and Caples, R. B., *Electrolytic Zinc Practice at Great Falls and Anaconda*: Eng. and Min. Jour., vol. 128, Aug. 24, 1929, p. 319.

TAINTON PROCESS⁶

In this process sulphuric acid of sufficient strength (28 to 30 per cent) is used, so that when heated it will dissolve the zinc ferrates formed in the roasting operation. For this reason roasting can be carried on rather freely, and it is claimed that increased capacity per roaster and greater extraction are achieved. Dust and fume from the roasters are collected in Cottrell treaters and flues and returned to the system. The calcines are separated into magnetic and nonmagnetic materials. The former carries the zinc ferrate formed in roasting and amounts to 30 to 50 per cent of the total calcine.

Leaching of the calcines is carried on in batches. A quantity of the ferrate material is first agitated with return electrolyte, previously heated to 60° C., until the zinc ferrate is decomposed. Manganese dioxide ore is added to oxidize the iron. The oxide or nonmagnetic material is then added, until all of the iron is precipitated and the solution becomes neutral. This operation results in the removal of practically all iron, arsenic, and antimony from the solution. The chemical reactions, being exothermic, bring the temperature of the solution up to the boiling point, which facilitates filtration of the pulp and subsequent purification of the solution. The hot pulp is separated into (1) a residue containing iron, lead, silver, arsenic, and antimony, which is dewatered and dried for shipment to smelters, and (2) a solution containing zinc, copper, cadmium, cobalt, and manganese. Copper, cadmium, and cobalt are precipitated from this solution by the addition of zinc dust and agitation at 80° C., and this precipitate is given further treatment for the recovery of the various metals. The purified solution then passes through the electrolytic cells, where metallic zinc is deposited.

Each cell contains 20 lead-alloy anodes and 10 sheet-aluminum cathodes. Electrolysis is also a batch operation. The solution flows from a storage tank through a cooling system into the cells. The discharge from the cells passes through a thickener, where the manganese dioxide precipitated during electrolysis is separated out and prepared for market. The overflow from the thickener returns to the storage tank. When the acid strength of the solution in this closed circuit has increased to about 28 per cent, a quantity of solution is withdrawn for use in the leach and an equal volume of neutral solution containing 220 grams of zinc per liter is admitted, reducing the acid content of the entire circuit to about 22 per cent. Deposition of zinc is carried on at a current density of 100 amperes per square foot.

The zinc produced by this process is said to average better than 99.99 per cent zinc and to have many unusual properties which promise to extend the uses of zinc into new fields. The manganese dioxide recovered in this process is said to be pure enough for use in the manufacture of dry-cell batteries.

⁶ Tainton, U. C., and Leyson, L. T., *Electrolytic Zinc from Complex Ores*: Trans. Am. Inst. Min. Eng., vol. 70, 1924, p. 486.

Tainton, U. C., *The Sullivan Electrolytic Zinc Plant*: Eng. and Min. Jour., vol. 126, Dec. 1, 1928, p. 856.
Miller, Raymond M., *New Electrolytic Zinc Plant of Sullivan Mining Co.*: Min. Cong. Jour., vol. 15, January, 1929, p. 70.

WORLD ASPECTS

WORLD MINE PRODUCTION

Compilation of the world mine production of zinc is at best a difficult task, owing to complete lack of published data for some countries and to lack of uniformity in reports from the countries that do publish production data. The following table, compiled from official and semiofficial sources, is submitted as a partial record of the world mine production during the last five years. Supplementary data, based in part on estimates, are given in the yearbooks of the American Bureau of Metal Statistics and the Metallgesellschaft.

World production of zinc ore and concentrates, with estimated zinc content, 1924-1928, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924		1925		1926		1927		1928	
	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content
North America:										
Canada	(1)	244,864	(1)	249,563	(1)	268,010	(1)	275,067	(1)	284,645
Mexico	58,599	24,659	120,120	51,795	(1)	105,367	284,558	137,724	(1)	161,747
United States (recoverable zinc)	(1)	578,760	(1)	644,866	(1)	702,668	(1)	651,846	(1)	630,644
South America:										
Bolivia (exports) ..	485	(1)	6,210	2,750	17,560	7,937	12,889	5,900	5,529	2,261
Chile—										
Zinc ore	-----	-----	-----	-----	1,257	439	2,360	940	(1)	(1)
Zinc-lead ore	-----	-----	-----	-----	58	15	222	63	(1)	(1)
Peru	(1)	145	(1)	14,418	(1)	22,975	(1)	21,589	(1)	28,139
Europe:										
Austria ³	1,227	488	1,892	777	2,305	889	3,855	1,562	4,726	1,818
Belgium	850	(1)	10,201	(1)	12,461	(1)	14,090	(1)	(1)	(1)
Bulgaria	(1)	(1)	-----	-----	425	(1)	1,495	(1)	-----	-----
Czechoslovakia ..	690	(1)	1,057	(1)	540	(1)	856	444	559	291
Finland	-----	-----	-----	-----	1,714	638	2,968	1,189	1,398	660
France:										
Zinc ore	15,072	7,000	14,765	4,824	11,574	5,737	15,400	(1)	8,729	(1)
Zinc-lead ore	62,932		154,727		17,058		14,430	(1)	36,760	(1)
Germany ³	102,513	41,667	122,208	49,121	201,494	79,393	260,112	111,442	(1)	116,979
Great Britain	2,354	826	1,629	572	1,975	854	2,958	1,272	1,578	720
Greece—										
Zinc ore	4,861	1,191	7,594	1,957	34,751	6,000	30,597	5,564	17,671	3,526
Zinc-lead ore	81	9	614	61	-----	-----	4,452	445	9,496	950
Italy ⁴ —										
Zinc ore	151,473	58,302	177,085	68,886	177,932	70,675	222,085	84,836	220,319	84,633
Zinc-lead ore	855	168	1,883	426	20,061	4,028	5,864	557	1,563	207
Norway	1,389	633	853	327	165	32	333	108	100	22
Poland	237,867	109,700	375,313	140,000	405,007	148,900	337,874	125,500	309,190	130,000
Portugal	40	(1)	65	33	⁵ 540	212	382	153	(1)	(1)
Russia ⁶ —										
Zinc ore	2,676	(1)	3,430	(1)	913	(1)	1,697	(1)	(1)	(1)
Zinc-lead ore	7,400	(1)	23,091	(1)	32,082	(1)	33,205	(1)	(1)	(1)
Spain	116,721	41,921	167,939	48,816	201,335	58,829	132,178	47,057	122,141	(1)
Spitsbergen	-----	-----	236	153	145	90	-----	-----	-----	-----
Sweden	47,691	17,139	51,183	18,636	56,267	21,307	62,526	24,372	34,101	14,172
Yugoslavia	549	(1)	535	(1)	581	(1)	1,067	(1)	1,153	(1)
Asia:										
China (exports) ..	20,456	(1)	37,747	(1)	24,791	(1)	5,388	(1)	8,297	(1)
Chosen	1,051	(1)	3,579	(1)	7,102	(1)	3,684	(1)	5,322	(1)
India (British) ..	18,949	8,408	17,080	7,750	49,618	23,048	59,221	27,508	65,151	32,901
Indo-China	42,451	17,829	52,869	20,792	62,051	25,053	55,060	21,800	51,619	21,486
Japan	23,317	(1)	(1)	10,000	(1)	12,000	(1)	10,000	(1)	(1)

¹ Data not available.

² Estimated smelter recoveries.

³ Data relate to concentrates produced and ore sold without concentration.

⁴ In addition to the zinc and zinc-lead ores shown, Italy reported the following production of lead-zinc ore: 1924, 4,134 tons, average content not stated; 1925, 3,512 tons, average content, Pb. 16.12 per cent, Zn. 9.43 per cent; 1927, 3,753 tons, average content, Pb. 28 per cent, Zn. 7.54 per cent.

⁵ Includes some zinc-lead ore.

⁶ Year ended Sept. 30.

World production of zinc ore and concentrates, with estimated zinc content, 1924-1928, in metric tons—Continued

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924		1925		1926		1927		1928	
	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content
Asia—Continued.										
Russia ⁶ —Zinc-lead ore			345	(1)	2,204	(1)	59,845	(1)	(1)	(1)
Turkey	(1)	(1)	(1)	(1)	150	(1)	(1)	(1)	5,729	(1)
Africa:										
Algeria—										
Zinc ore	42,759	17,831	56,181	22,472	62,154	27,933	47,830	21,490	32,308	14,539
Zinc-lead ore			575	230	473	99	110	23	2,664	559
Kenya Colony							12	(1)	(1)	(1)
Morocco, French ⁷					99	34	184	71	647	(1)
Nigeria							21	10	126	(1)
Northern Rhodesia			6,298	(1)	453	(1)	(1)	(1)	(1)	13,387
Tunisia—										
Zinc ore	14,811	5,200	22,000	7,590	30,000	9,000	18,000	6,300	10,000	3,500
Zinc-lead ore			9,000	1,395	7,000	1,155	9,000	1,500		
Oceania:										
Australia ⁸	(1)	109,855	(1)	141,010	(1)	153,298	(1)	174,283	(1)	150,236
New Caledonia			2,000	620	2,200	638	1,500	450		

¹ Data not available.

⁶ Year ended Sept. 30.

⁷ Exports.

⁸ Produced mainly in New South Wales.

In 1927 the world produced ore containing approximately 1,570,000 metric tons of zinc, of which the United States contributed 42 per cent; Australia, 11 per cent; and Mexico and Poland, the two next largest contributors, about 9 and 8 per cent, respectively. Germany, Italy, Canada, and Spain followed next in order, with 7, 5, 5, and 3 per cent, respectively. British India, Sweden, Indo-China, Peru, and Algeria each produced between 1 and 2 per cent of the world total, and each of the remaining countries produced less than 1 per cent.

Although the United States is by far the largest producer of zinc in the world, its relative position has declined somewhat since 1926. In that year the United States output was 45 per cent of the world total. In 1927 it declined to 42 per cent, and from preliminary data available for 1928 the proportion appears to be still lower. During 1927 and 1928 there were substantial decreases in the mine production of the United States, due largely to a decrease of 95 per cent in exports of ore resulting from lower zinc prices. A falling off in the domestic consumption of zinc in 1927 also contributed to the curtailment of mine output.

Coincident with this decline in the United States since 1926 there have been marked increases in the production of some important countries, but decreases are noted in Australia, Poland, and Spain.

The zinc content of ore produced in Mexico in 1928 was 54 per cent more than in 1926; in Canada, 24 per cent more; and in Italy, 14 per cent more. Data on 1928 world mine production are too incomplete at this time to permit an estimate of total output, but from data available it appears to be slightly under 1927.

WORLD SMELTER PRODUCTION¹

The following table shows the world smelter production of zinc from 1924 to 1928, as far as statistics are available. Official figures are used wherever possible. For countries for which official data are not yet available the figures are taken from the Year Book of the American Bureau of Metal Statistics and other reliable sources, but the official statistics will be substituted as received.

There is always possibility of duplication in figures showing European production, as some countries send crude zinc of poor quality to other countries for refining. Furthermore, secondary zinc probably is included in figures of production reported by some foreign countries. The figures for such countries are therefore not fully comparable with the figures for production of primary zinc in the United States, as given in the following table:

World smelter production of zinc, 1924-1928, in metric tons, by countries where smelted

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924	1925	1926	1927	1928
Australia.....	47, 116	46, 431	48, 116	49, 944	51, 029
Belgium.....	161, 700	170, 860	188, 767	199, 090	209, 280
Canada.....	24, 896	34, 892	55, 998	66, 413	74, 176
China.....	203	305	300	(1)	(1)
Czechoslovakia.....	6, 897	3, 042	2, 789	6, 324	8, 039
France.....	57, 712	64, 256	64, 188	82, 605	96, 873
Germany.....	40, 910	62, 494	73, 716	89, 837	98, 256
Great Britain.....	39, 098	38, 761	18, 278	42, 541	56, 284
Indo-China.....	72	1, 158	1, 858	1, 170	3, 000
Italy.....	5, 959	6, 478	7, 636	7, 367	10, 564
Japan.....	14, 069	16, 950	16, 972	17, 558	19, 117
Mexico.....		1, 304	5, 942	6, 431	11, 220
Netherlands.....	18, 190	21, 117	24, 796	26, 268	26, 855
Northern Rhodesia.....		240	240		9, 733
Norway.....	5, 024	6, 807	5, 359	5, 488	
Poland.....	93, 086	114, 339	123, 741	150, 299	161, 815
Russia ²	517	1, 492	1, 888	2, 266	4, 300
Spain.....	12, 777	15, 122	16, 065	16, 531	13, 549
Sweden.....	3, 451	4, 672	4, 766	4, 647	5, 106
United States.....	469, 320	519, 765	561, 020	537, 519	546, 649
Yugoslavia.....	2, 126	2, 075	2, 376	3, 185	4, 883
	1, 003, 000	1, 133, 000	1, 225, 000	1, 315, 000	1, 411, 000

¹ Data not available.

² Year ended Sept. 30.

The United States is by far the leading producer of zinc in the world. In 1927 it produced 41 per cent and in 1928, 39 per cent of the world total. The slight decrease in relative importance in 1928 was due to the fact that its output increased only 2 per cent, while that of the world increased 7 per cent. Belgium was the second largest producer, with 15 per cent of the 1928 world total to its credit. Poland ranked third, with 11 per cent; Germany fourth, with 7 per cent; France fifth, with 6.9 per cent; Canada sixth, with 5 per cent; Great Britain seventh, with 4 per cent; and Australia eighth, with 3.6 per cent. All of these foreign countries except Australia had substantial increases in production in 1928, ranging from 5 to 32 per cent. Among the smaller producers Japan, Mexico, Italy, Czechoslovakia, and Russia had substantial increases

¹ The reader is referred to Pehrson, E. W., Summarized Data of Zinc Production: Econ. Paper 2, Bureau of Mines, 1929, for a summary of the world zinc industry from 1801 to 1927, inclusive.

in output. Northern Rhodesia became an important producer for the first time in 1928, due to the beginning of new operations at Broken Hill.

The world production of electrolytic zinc is expanding at a rapid rate. The American Bureau of Metal Statistics reports the 1928 output at about 330,000 short tons, representing 21 per cent of the total zinc produced and 39 per cent greater than 1926. In 1928 the United States produced 49 per cent of the world total, Canada 25 per cent, and Australia 17 per cent. France, Northern Rhodesia, Italy, Poland, and Japan contributed the remaining 9 per cent. The maximum daily capacity of all plants operating in 1928 was 1,341 tons. At the end of the year additional installations totaling 275 tons were under construction, and plans were under way for new plants in France, Germany, Canada, and Peru and for increased capacity at Broken Hill, Rhodesia.

WORLD ZINC INDUSTRY

Summaries of the zinc industry in the more important zinc-producing countries follow.

NORTH AMERICA

CANADA

During the past five years the production of zinc in Canada has nearly tripled. In 1928, 81,765 short tons was produced, an increase of 12 per cent over 1927 and equal to 5 per cent of the world total. Present operations indicate a greatly increased output in the near future.

At present there is only one zinc-reduction plant in Canada, the electrolytic plant of the Consolidated Mining & Smelting Co. at Trail, British Columbia. This plant had a maximum daily capacity of 300 tons of zinc and was the second largest electrolytic zinc plant in the world. At the close of 1928 its daily capacity was being increased by 100 tons. When completed this plant will be the largest in the world. The Hudson Bay Mining & Smelting Co., which is developing the Flin Flon ore body, plans to erect an electrolytic zinc plant with a capacity of 25,000 to 30,000 tons of refined zinc per year. A third plant is being considered, to be located in eastern Canada to handle the ores produced in Ontario and Quebec.

In 1928 zinc ore containing 92,324 tons of recoverable zinc was produced in three Provinces, of which British Columbia produced approximately 89 per cent, Quebec 11 per cent, and Ontario a trifling amount. The British Columbia ore is practically all treated at Trail, while the Quebec ore is shipped to Europe for treatment. In 1928 ore containing 11,255 tons of recoverable zinc was exported to Belgium. Of the 63,594 tons of slab zinc exported from Canada in 1928, 27 per cent went to Japan, 17 per cent to Great Britain, and the balance to miscellaneous countries.

Brief comments on the zinc resources of Canada follow:⁸

British Columbia.—By far the largest lead-zinc mine in Canada and probably the largest in the world is the Sullivan mine of the Consolidated Mining & Smelting Co. In 1928, 1,554,070 tons of ore from this mine was treated, producing 204,657 tons of lead concentrates and 198,010 tons of zinc concentrates. In addition to other smaller mines this company operates large reduction plants at Tadanac and Trail, British Columbia, for treatment of its own and custom ores. These plants received 603,756 tons of ores and concentrates in 1928, of which 504,076 tons came from mines owned by the company. The ore and concentrates received from 107 custom shippers were distributed as follows:⁹

Custom ore shipped to the Consolidated Mining & Smelting Co., 1928, by districts

District	Tons shipped	Number of shippers
Slocan-Ainsworth-Lardeau.....	30, 298	47
Boundary Similkameen.....	29, 080	18
Nelson-Arrow Lakes.....	7, 527	10
State of Washington.....	29, 080	16
East Kootenay.....	1, 108	6
Scattered (British Columbia).....	2, 515	10
Total.....	99, 608	107

The company's production during the past two years has been reported as follows:¹⁰

Ore and metals produced by the Consolidated Mining & Smelting Co., 1927-28

	1927	1928		1927	1928
Ore..... tons..	1, 405, 872	1, 665, 586	Lead..... pounds..	201, 043, 120	318, 831, 578
Gold..... ounces..	29, 490	23, 623	Copper..... do....	18, 522, 742	17, 806, 306
Silver..... do....	7, 179, 607	7, 673, 762	Zinc..... do....	147, 054, 623	163, 530, 890

The Sullivan ore body, a mass of sulphides containing pyrite, pyrrhotite, sphalerite, and argentiferous galena, is a replacement of quartzites and argillites which are parts of a sedimentary series of late pre-Cambrian age. The formation strikes north and south, with an average dip of 23° to the east. The sulphide lens has a maximum thickness of 272 feet and a known length of over 6,000 feet, with ore in the north and south ends. Mining is conducted on two levels, at 4,600 and 3,900 feet above sea level. On the upper level the north and south ore bodies are separated by 700 feet of pyrite, while on the lower level 1,100 feet of pyrrhotite separates the two zones. The extent of the deposit below the 3,900-foot level has not been determined. Data on ore reserves are not available, but the 1928 annual report of the Consolidated Mining & Smelting Co. stated that the reserves of the company were well maintained and sufficient

⁸ For an excellent summary of the zinc resources of Canada the reader is referred to a paper prepared by the Canadian Department of Mines and presented by Charles Camself, deputy minister of mines, at the 1929 meeting of the American Zinc Institute. The paper is printed in full in *Zinc*, vol. 12, Nos. 5-6, May-June, 1929, p. 82.

⁹ Canadian Mining Journal, vol. 50, Jan. 25, 1929, p. 82.

¹⁰ Engineering and Mining Journal, vol. 127, Apr. 27, 1929, p. 699.

for many years of profitable extraction. The content of the ore has been reported as follows: Lead, 11 per cent; zinc, 7.5 per cent; iron, 40 per cent; and silver, 4.2 ounces per ton.¹¹

There are a number of districts in British Columbia where complex lead-zinc ores are being or soon will be treated by selective flotation. The successful development of this process, together with the ready market for concentrates at the Trail reduction works, has greatly increased the mining activity in these districts, and a large increase in production is anticipated. In the Slocan district five new mills were put into operation in 1928. There was also considerable activity in the Kootenay and Monarch districts, where several small ore bodies have been developed. At the Reeves-McDonald property, situated on the Pend d'Oreille River near the international boundary, an ore body has been developed that is said to contain 2,000,000 tons of proved ore with indications of still larger reserves. As developed, it is 640 feet long and has an average width of 30 feet. The metal content averages 7 per cent zinc, 2 per cent lead, and 0.5 ounce silver. It is planned to develop a sufficient tonnage to warrant the erection of a plant suitable for large-scale production.

Quebec.—This Province was the only other producer of zinc of any consequence in the Dominion in 1928, and practically all of its output came from the Tetreault mine, located near Notre Dame des Anges, 78 miles west of Quebec. The ore is an intimate mixture of sphalerite, galena, pyrrhotite, and pyrite, with a little chalcopyrite, carrying small but appreciable amounts of gold and silver. It occurs fairly uniformly along the footwall of a tremolite carbonate band with gradual dissemination toward the hanging-wall side. Locally rich irregular pockets of high-grade ore are found. Mining has been carried to a depth of 500 feet. The daily production is 450 to 500 tons of ore averaging 9 per cent zinc, 3 per cent lead, 0.1 per cent copper, 0.09 ounce of gold, and 8.3 ounces of silver. The ore is concentrated by selective flotation into zinc and lead concentrates, which have been shipped to Belgium for treatment. This property has been operated almost continuously since 1913, but its future is somewhat problematical.

Some promising zinc prospects are located in central Gaspé, but the mineral districts of western Quebec now appear to offer the best possibilities for future zinc production in this Province. Many of the copper deposits of the Rouyn district contain substantial amounts of sphalerite, and it is believed that zinc soon will be an important by-product of the copper producers as the leaner complex copper ores are utilized. The Noranda concentrator is already producing a small amount of zinc concentrate, and a recent announcement that a syndicate, which includes Noranda Mines (Ltd.), intends to build a copper refinery and an electrolytic zinc plant on the St. Lawrence River, somewhere between Montreal and Quebec, may be significant. Amulet has an ore reserve reported at 435,000 tons, containing 10.6 per cent zinc, 2.8 per cent copper, 2.84 ounces of silver, and 97 cents in gold. It was announced early in 1928 that at the Waite Montgomery property 455,000 tons of ore averaging 8.6 per cent zinc and 2.4 per cent copper was developed by diamond drilling.

Ontario.—Extensive development of lead-zinc deposits has occurred in the Sudbury district during the past few years, and present

¹¹ Engineering and Mining Journal, vol. 124, Oct. 1, 1927, p. 538.

indications are that this district will soon become an important producer. The most important development to date is the Errington mine of the Treadwell Yukon Co., which is controlled by the Bunker Hill & Sullivan Mining & Concentrating Co. of Idaho. This property has been developed by shafts to a depth of 500 feet and diamond drilling has proved ore to a depth of 1,200 feet. Data as to the extent of the ore body are not available, but it was announced that 1,000,000 tons of ore was developed in one ore body above the 300-foot level. The samples averaged 0.021 ounce gold, 2.15 ounces silver, 1.33 per cent copper, and 5.74 per cent zinc. Other parts of the property contain considerable lead. During 1928 a 300-ton pilot mill was operated, which produced lead, copper, and zinc concentrates, but the metallurgical results were not entirely satisfactory.

Sudbury Basin Mines (Ltd.) is developing a property adjoining the Errington mine by diamond drilling, and a large amount of ore has been indicated. No attempt has been made to estimate tonnage, but a continuous length of 1,500 feet of ore has been indicated to a depth of at least 500 feet. Widths of known ore bodies range from 20 to 70 feet. The character and grade of ore are said to resemble closely the Errington ore.

Sudbury Contact Mines, which adjoins Sudbury Basin on the south, is the only other property on which work is being done in this area. At Lake Geneva, outside the Sudbury district proper, Towagmac Exploration is developing a property and some ore has been encountered. It is said that this property may eventually produce from 100 to 200 tons of concentrate per day.¹²

The future production expected from these properties suggests the possibility of an electrolytic zinc plant in the Sudbury area. The lack of cheap power, which at present offers obstacles to profitable operation of such a plant, may be remedied by elaborate power developments planned by the Ontario Government. Early in 1929 the Consolidated Mining & Smelting Co. and Ventures (Ltd.), which is closely allied with Sudbury Basin and Sherritt-Gordon Co., announced plans for an electrolytic zinc plant and copper refinery in eastern Canada. Subsequently, however, these two companies joined with International Nickel Co. and American Metal Co. (Ltd.) to construct a copper refinery, but no statement was made concerning the zinc plant. It has been pointed out that Ventures will require a zinc plant for handling its zinc ores, and with cheap power and additional sources of ore available Sudbury would seem a natural location for such a plant.

Manitoba.—Within the next few years this Province will probably become the second largest producer of zinc in Canada. The district now being developed for production lies midway between the north and south borders of the Province and close to the Saskatchewan border on the west. The principal properties are the Flin Flon, Sherritt-Gordon, and Mandy. During 1928, 90 miles of railroad from The Pas on the Canadian National Railway to the Flin Flon property was completed, and construction of a 42-mile extension from Flin Flon to the Sherritt-Gordon mine was started.

The Flin Flon ore body was discovered in 1915, and development has been carried on by a number of companies. In 1925 the Mining

¹² Engineering and Mining Journal, vol. 127, June 8, 1929, p. 930.

Corporation of Canada optioned the property to the Whitney interests of New York. Late in 1927 the option was exercised and ownership is now vested in the Hudson Bay Mining & Smelting Co. (Ltd.), which is controlled by Whitney and associates.

According to late official reports (July, 1929) the developed ore reserves amounted to 18,000,000 tons above the 900-foot level. The ore body is about one-half mile long and averages 70 feet in width. On the 900-foot level it is narrower, but no decrease in grade is apparent. Allowing for dilution, the ore contains 1.71 per cent copper, 3.45 per cent zinc, 0.074 ounce gold, and 1.06 ounces silver. Approximately one-third of the developed ore will be mined on the surface with electric shovels. Plans have been made for a daily production of 3,000 tons of ore.

Copper will be reduced to blister in a smelter at the property, and the zinc concentrates will be reduced to refined zinc at a local electrolytic plant. These plants will treat custom ore as it becomes available. Power will be supplied by a 35,000-horsepower hydroelectric plant at Island Falls, 60 miles from the mine. This plant will be enlarged to supply other operators of the district as needed. Production is expected in 1930, and the annual output will be about 15,000 tons of copper, 25,000 tons of zinc, and corresponding amounts of gold and silver.

The Sherritt-Gordon ore body, which lies about 40 miles northeast, is less fully developed than Flin Flon, but latest advices indicate that it is of the same order of magnitude and of similar character but slightly higher grade. The ore occurs as veinlets and replacements in a long narrow fracture zone in sedimentary gneisses and closely follows the dip and strike of the beds. The ore minerals are pyrrhotite, sphalerite, chalcopyrite, and chalmersite (copper-iron sulphide). Galena occurs very sparingly. There has been no official announcement of proved ore reserves as yet, but it has been reported unofficially¹³ that above the 375-foot level the ore body is about 1½ miles long, with an average width of 15 feet. It has been estimated that the average content would be not less than 3 per cent copper, 4 per cent zinc, and \$1 in precious metals. Diamond drilling has shown that the ore bodies continue below the 375-foot level.

Present plans include the erection of a concentrator with 1,500 tons daily capacity; construction will begin when the railroad extension from Flin Flon is completed, which is expected before the end of 1929. In July, 1929, a pilot mill was being built to develop the flow sheet. The company has arranged to purchase power from the Island Falls plant of the Hudson Bay Mining & Smelting Co. The latter company will treat the Sherritt-Gordon copper concentrates at its Flin Flon smelter; it was recently announced¹⁴ that the Sherritt-Gordon zinc concentrates will be treated at the electrolytic zinc plant to be erected in eastern Canada jointly by Ventures (Ltd.) and Consolidated Mining & Smelting Co. Production is expected to start in 1931 and should approximate 18,000 tons of zinc and 12,000 tons of copper per year.

The Mandy mine, 3½ miles southeast of Flin Flon, was discovered in 1915, and during the World War 25,000 tons of high-grade copper ore was shipped to Trail, British Columbia, for smelting. Lower-grade

¹³ Canadian Mining Journal, vol. 50, Aug. 16, 1929, p. 764.

¹⁴ Canadian Mining Journal, vol. 50, June 28, 1929, p. 611.

ore containing considerable zinc proved to be unworkable, owing to difficult transportation, but with the prospects of a railway being built development work was begun in 1928. At the end of the year it was announced that the shaft had reached the 525-foot level and that it would be extended to 800 or 1,000 feet. No official statement of ore reserves is available, but it has been reported that the developed ore amounts to 200,000 tons, containing 20 to 30 per cent zinc, between 5 and 8 per cent copper, and small amounts of gold and silver. The ore will probably be treated in the Flin Flon plant.

During the summer of 1928 a zinc-copper mineralized zone 800 feet long and up to 20 feet wide was indicated by surface work and diamond drilling on the east side of Reindeer Lake, about 200 miles north of Flin Flon.

Nova Scotia.—The only known property in Nova Scotia that is a potential zinc producer is the Stirling mine, on Cape Breton Island about 40 miles southwest of Sydney and about 4 miles inland from the Atlantic coast at Framboise Cove. A number of unsuccessful attempts at operation were made up to 1927, when the British Metal Corporation of Canada (Ltd.) reopened the previous workings. In December, 1928, this company reported a reserve of 200,000 tons of ore between the 200-foot level and the surface. Plans call for the erection of a 250-ton flotation plant to handle the complex ore. The chief product will be zinc concentrates, which will be shipped to Europe until a market opens up in eastern Canada.

Miscellaneous.—There are some undeveloped zinc-lead deposits about 32 miles southwest of Fort Resolution on Great Slave Lake, Northwest Territories. The ore-bearing areas are 100 to 900 feet in length and average 200 feet in width. Some zinc occurs in the silver-lead ore bodies of the Beaver River district, about 50 miles north of Keno Hill, Yukon, but as yet there has been no production of zinc. Both of these districts are so isolated that they can not be considered of immediate importance.

MEXICO

Since the introduction of selective flotation into Mexico the production of zinc has increased at a remarkable rate. In 1928 ore containing 161,747 metric tons of zinc was produced, an amount exceeded only by the United States. The 1928 output was an increase of 17 per cent over 1927.

Only a small part of the Mexican output is smelted at home. In 1928 the smelter output amounted to 11,220 metric tons, all produced by a single active smelter at Rosita, Coahuila, which has an annual capacity of about 12,600 tons.

It was reported in July, 1929,¹⁵ that this plant, which is owned by a subsidiary of the American Smelting & Refining Co., was being enlarged so that by the end of 1930, when present contracts with European smelters expire, it will be able to handle 12,000 tons of concentrates per month, or practically all of the company's output in Mexico. It was also rumored that the Mexican Government proposed to subsidize the erection of a zinc smelter and electrolytic zinc plant.¹⁶

The surplus concentrates are exported chiefly to Europe. In 1928 Belgium imported 55,571 tons, Germany 48,611 tons, and France 47,657 tons.

¹⁵ Arizona Mining Journal, vol. 13, July 30, 1929, p. 49.

¹⁶ Metal Bulletin, London, Aug. 17, 1928, p. 17.

Zinc ores are widely distributed in Mexico and are usually associated with lead and silver. In 1927 eleven States contributed to the country's output. Chihuahua was the most important producer, having contributed 55 per cent of the total. San Luis Potosí produced 15 per cent, Zacatecas and Coahuila 10 per cent each, and Puebla 4 per cent. Durango, Jalisco, Hidalgo, Nuevo León, Aguas Calientes, and Tamaulipas were next in importance in the order named.

NEWFOUNDLAND

The Buchans mine promises to become an important producer, according to a report recently published. This property is held by a partnership consisting of the Anglo-Newfoundland Development Co. (Ltd.), which owns the property, and the American Smelting & Refining Co., which operates the property and provides the capital necessary for development. Net profits are shared equally. At the annual meeting of the Anglo-Newfoundland Development Co. (Ltd.) in London, January, 1929, the following report of H. A. Guess, vice president of the American Smelting & Refining Co., was read:

Explorations were started by us in the summer of 1926, and we utilised for such explorations the Lundberg method of electrical prospecting, with the result that by September, 1926, we had thereby discovered throughout an east-west zone of some 8,000 ft. length one very large ore body designated as Lucky Strike and lying at the western end of the zone, and a group of smaller ore bodies at the eastern end of the zone, and designated Oriental. Also two small lenses of ore in the vicinity of the original Buchans discovery of some years ago.

The drilling so far done at Oriental is insufficient to enable any definite estimate to be made as to tonnage and grade, but in the tabulation below there is given an estimate of the five known ore bodies:

	Short tons
Lucky Strike ore body.....	4,750,000
North, east, and also west of Lucky Strike.....	575,000
Buchans old ore body.....	100,000
Oriental west ore body.....	125,000
Oriental east ore body.....	200,000
	5,750,000

When, some weeks ago, severe weather conditions rendered it advisable to discontinue electrical prospecting until next spring, the electrical prospecting was obtaining some fairly encouraging indications within an area about 9 miles easterly from Lucky Strike ore body. This does not necessarily indicate any ore, but it will be investigated next spring.

One-half of the mill was started early in September and has since been continued.

It was apparent, however, after the mill had been running a month or so, that upon this ore, which is the most difficult of separation that we have ever encountered, additional flotation equipment would be needed to enable a more prolonged treatment and to reclean both the lead and zinc concentrates, and thereby bring them up in grade.

Some of this additional equipment is now being installed, and by the end of January the benefits therefrom in the way of improvement in recoveries and grade of product, and correspondingly in profits, will begin to appear.

Meantime, upon the present partial tonnage basis and with recoveries and grades of products considerably short of that set as the objective, the profit, before any amortisation or Newfoundland royalty deductions, has for October and November been \$85,998 upon 16,973 dry tons milled, or approximately \$5.00 per ton.

Considering now the above-mentioned ore reserves of 5,750,000 tons, the average assay values are: Gold, .033 oz.; silver, 3.25 ozs.; copper, 1.4 per cent; lead, 7.65 per cent; zinc, 17.85 per cent.

This tonnage of nearly 6,000,000 tons, representing, as it does, nearly 40 years' life at capacity of present mill, justifies an enlargement of the mill to approximately 1,000 tons daily, or, say, 300,000 tons per year, and, moreover, the cost of such mill, power, and other enlargements would very quickly be returned in decreased per ton operating costs.

SOUTH AMERICA

PERU

As a result of the application of selective flotation to the complex ores of Casapalca during the past few years, Peru has become an important producer of zinc. In 1928 ore containing 28,139 metric tons of zinc was produced, most of which was exported to Europe for smelting.

The Cerro de Pasco Copper Corporation produced about 20,000 metric tons of zinc concentrates. The company recently announced that a \$15,000,000 building program had been authorized, including a larger power plant on the Montaro River, an electrolytic zinc plant at Oroya with two concentrators of 1,000 tons and 600 tons daily capacity, and miscellaneous mine development and surface construction. The program will be completed within three or four years.¹⁷

EUROPE

AUSTRIA

Austria depends largely on imports for its supply of nonferrous metals, and zinc is no exception, as there is no zinc smelter in the country. The production of zinc ores has shown a continuous upward trend in recent years, although only eight mines were in operation in 1928, compared with nine in 1926 and 1927. The 1928 output was estimated at 130,000 tons of lead-zinc ore, from which approximately 9,400 tons of lead concentrates and 4,700 tons of zinc concentrates were produced. Over 80 per cent of the total output was mined in Carinthia, practically all by the Bleiberger Bergwerks Union A. G. at its mines at Bleiberg-Kreuth and Eisenkappel. The balance was produced in the Provinces of Tyrol and Styria. The zinc concentrates were exported chiefly to Czechoslovakia and Germany. The only domestic zinc-rolling mill, the Fried v. Neuman in Marktl, Lower Austria, with an annual output of about 1,000 metric tons of sheet zinc, worked at fair capacity recently to supply the domestic market.¹⁸

Austria imported 7,741 tons of crude and scrap zinc in 1928, Poland, United States, and Germany being the principal contributors.

BELGIUM

Belgium has been one of the most important zinc producers since the world zinc industry began early in the nineteenth century. Its early importance was due to favorable deposits of coal and zinc ore; but by 1860 the supply of ore was inadequate for the rapidly expanding smelting industry, and Belgium became the world's leading importer of zinc ore. In 1928, 209,280 metric tons of zinc was produced, exceeding all previous records and comprising 15 per cent of the world total. It is estimated that about 97 per cent of the output was produced from imported ores. The success of the smelting industry in Belgium is based chiefly on cheap labor and fuel.

The entire Belgian output is derived from 13 retort smelters having a combined estimated annual capacity of 267,900 metric tons of

¹⁷ Mining Congress Journal, vol. 15, June, 1929, p. 509.

¹⁸ U. S. Department of Commerce, Commerce Repts., No. 22, June 3, 1929, p. 593.

zinc. Three of these, representing 33 per cent of the total capacity, are operated by the Société Anonyme de la Vieille Montagne. This company owns mines in many parts of the world and operates two zinc smelters in France and one in Germany. In 1928 it produced 111,000 metric tons of zinc—about 8 per cent of the world output and second only to the output of the Anaconda Copper Mining Co. The 1929 output is expected to approximate 125,000 tons. During the year the company was actively engaged in modernizing its various plants, to eliminate some hand labor, and in improving metallurgical practice.

Another important producer of zinc in Belgium is the Cie. des Métaux d'Overpelt-Lommel et de Corphalie. This company operates three smelters having a maximum combined capacity of 75,000 tons of zinc per year.

During the year it was reported that a new concern was to be formed to exploit a new roasting process.

Under the protection of the Société Générale de Belgique, whose influence in Belgian industrial circles continues to expand, a new concern is shortly to be formed, with a capital of 30,000,000 francs, to exploit a new process of roasting zinc ore and to interest itself also in the manufacture of by-products, especially sulphuric acid. The works will be at Willebroeck. The founders include the Produits Chimiques de Laeken, the Métallurgique de Prayon, the Soc. Anon. de Rothem, the Soc. Mét. de Boom and the Cie. des Métaux d'Overpelt-Lommel et de Corphalie. It is regarded as probable that the Nouvelle-Montagne will also join the group. The Schlesische Zink (Lipine) has acquired the Polish rights of the process and is erecting a roasting plant at Danzig. The group does not include the Vieille Montagne concern. The latter is credited, however, with the intention of modernizing its furnaces, for which purpose an increase in capital will be necessary.¹⁹

It was also reported that the Ougrée-Marihaye Co.²⁰ and other interests propose to resume operations at the Vindrin (Namur Basin) zinc and lead mine, which has been idle since 1880. The only zinc mine of any importance in Belgium at the present time is that of the Vieille Montagne at Moresnet.

FRANCE

France produced 96,873 metric tons of zinc in 1928, an increase of 17 per cent over 1927. In the same year it is estimated that France consumed about 126,000 tons of zinc, requiring a net import of about 29,000 tons. Actual imports were over 42,000 tons, of which Belgium supplied 67 per cent. Nearly 14,000 tons of zinc was exported from France in 1928.

Metallic zinc is produced in this country in six smelters having a combined capacity of 85,000 tons annually and in one electrolytic plant of 36,000 tons annual capacity. Less than 10 per cent of the zinc produced at these plants is derived from ores mined in France, but a large part of the imported ores comes from French colonies. In 1928, 227,000 tons was imported of which the colonies supplied about 27 per cent, Spain 25 per cent, Mexico 21 per cent, Italy 16 per cent, and Australia 9 per cent. It is claimed that France could make itself almost independent of foreign sources of zinc supply by utilizing the deposits in colonies and dependencies, particularly in Morocco. The production of French colonies and protectorates is now rather

¹⁹ Metal Bulletin, London, Sept. 25, 1928, p. 17.

²⁰ Metal Bulletin, London, Aug. 31, 1928, p. 17.

small, but the present French tendency to substitute domestic or colonial products for foreign imports may eventually develop resources to a degree that will cause a large reduction of the present importation.²¹

Vieille Montagne reported that large installations were in progress at Port-de-Bouc for the reception and roasting of ores destined for their electrolytic zinc plant at Viviez, the production of which is to be augmented as soon as additional power can be made available.²² This plant produced 13,700 tons of zinc in 1928.

The erection of a second electrolytic plant in France was being planned by Peñarroya.

In 1927 Russo-Asiatic Consolidated (Ltd.) acquired control of the Compagnie Nouvelle des Mines de Villemagne and Mines de St. Sebastien-d'Aigrefeuille. At that time underground work on a section of the Villemagne ore body indicated 3,000,000 tons of ore containing 12½ per cent combined lead and zinc and 3 ounces silver. For 1928 this company reported that the mill had been enlarged to 500 tons daily capacity, 106,000 tons of ore was milled, and 9,307 tons of zinc concentrates and 2,830 tons of lead concentrates were produced. The 1929 output was expected to reach 145,000 tons of ore. At St. Sebastien 1,500,000 tons of ore averaging 4 per cent lead, 1½ per cent zinc, and 2½ ounces silver has been developed, with possibilities for a much greater tonnage. The ore occurs in a flat bed ranging from 2 to over 5 meters in thickness. The formation is 5 kilometers long and 300 to 400 meters wide. The ore is apparently just under grade for profitable operation at the present price of lead, but large-scale operations are expected if and when lead becomes stabilized at a higher price.

GERMANY

Germany ranked fourth in world production of zinc in 1928, with an output of 98,256 metric tons, 7 per cent of the world total. Throughout the nineteenth century this country was the world's leading producer, a position it retained until finally the United States gained the leading position in 1909. The zinc industry of Germany was formerly located mainly in two regions. In Upper Silesia there was a large smelting industry supported by ores mined locally, and in the Rhine Provinces there were many smelters operating largely on imported ores. In 1922 Poland was ceded a large part of Upper Silesia, including the entire zinc-smelting equipment of this area, so that at present the ores mined in German Upper Silesia are exported for smelting. In 1928 Germany exported over 200,000 metric tons of ore, three-fourths of which went to Polish Upper Silesia. The Rhine district zinc smelters still operate on imported ores. In 1928 Germany imported over 162,000 metric tons of ore. Mexico, Greece, Australia, and Spain were the chief contributors.

The lack of smelting facilities within German borders in Upper Silesia proved to be unsatisfactory to German ore-producing companies. The Georg von Giesche's Erben, one of the large operators in the district, considered erecting a large modern electrolytic refinery on the spot, but after due consideration finally decided to erect the plant at Magdeburg, on the Elbe River, owing to more favorable

²¹ U. S. Department of Commerce, Foreign Trade Notes, No. 223, December 8, 1928.

²² American Metal Market, July 4, 1929.

markets for the by-products of zinc reduction. The plant will have an annual capacity of 50,000 metric tons, more than one-fifth of the German zinc requirements. It is expected to be in operation at least by the beginning of 1933.

During 1928 the zinc smelters of Germany had a combined annual capacity of about 123,000 metric tons. The estimated consumption of zinc was 204,000 tons, second only to that of the United States. Of this amount 98,000 tons was produced locally, leaving a net import of 106,000 tons. Actual imports were 143,000 tons, and 37,000 tons was exported. Polish Silesia supplied about half of the total imports, followed by Belgium, United States, and Canada. About 63 per cent of Germany's zinc export went to Great Britain.

GREAT BRITAIN

The consumption of zinc in Great Britain in 1928 was estimated at 184,100 metric tons, while the smelter production amounted to 56,284 tons. About 138,000 metric tons was imported and nearly 10,000 tons exported. Belgium supplied 38 per cent of the imports, Germany 19 per cent, Canada about 8 per cent, Australia about 8 per cent, and other countries 27 per cent.

The zinc production of Great Britain is almost entirely derived from imported ores; the domestic mines produced less than 1,000 tons of zinc in 1928. About 172,000 metric tons of ores, concentrates, etc., were imported in 1928, most of which came from Australia. During the World War, when Australian concentrates could not be marketed in Germany and Belgium, the British Board of Trade contracted to purchase a large quantity of concentrates over a period of several years. For the year ended March 31, 1928, the loss of the board of trade under this contract amounted to 973,000 pounds sterling, which increased the total loss since 1918 to 4,667,000 pounds. The contract expires in 1930.

Great Britain has a smelting capacity of about 79,000 metric tons of zinc per year, nearly half of which is controlled by the National Smelting Co. (Ltd.). This company has a long-term lease on the 23,000-ton Swansea Vale Works at South Wales and owns a 13,000-ton plant at Avonmouth. It has been operating on Australian concentrates under a contract with the British Government that expires June 30, 1930. Anticipating the necessity of finding new sources of raw materials, a new company, Imperial Smelting Corporation (Ltd.), is to be formed to take over the business. Several important zinc ore producers will participate in the new organization, including the Burma Corporation, South Broken Hill (Ltd.), North Broken Hill (Ltd.), the Electrolytic Zinc Co. of Australia (Ltd.), and the Zinc Corporation. Substantial additions to both plants have been authorized, and an increase in the company's activities is anticipated.

The Sulphide Corporation (Ltd.) operates a 10,000-ton zinc smelter at Seaton Carew and produced 8,500 metric tons of zinc in 1928. The company now has a mine in South Wales, a few miles from Llandovery, which is expected to supply the plant with zinc concentrates when its contract with the board of trade terminates in 1930.

No electrolytic zinc plant is operating in Great Britain at present, but the Chemical & Metallurgical Corporation (Ltd.) is considering

one to be used for treating zinc residues from its large ore-treating plant which is being built at Runcorn. This plant is designed to treat complex lead-zinc ores by the Elmore process.

ITALY

The mines of Italy in 1928 produced ore containing about 85,000 metric tons of zinc, most of which was exported for treatment, largely to Belgium, France, and Germany. Only 10,564 metric tons of metallic zinc was produced in 1928.

A large part of the zinc ore comes from the Iglesias district on the island of Sardinia, where about 50 mines were active. Increased production is expected from this district in future, as a result of improvements now in progress. The mines are controlled largely by foreigners, including American, Belgian, and French interests. The northern Provinces of Trieste and Milan are also important producers.

There were four zinc-reduction plants in Italy in 1928. The largest of these, a smelter at Vado Ligure, Province of Genova, had an estimated annual capacity of 6,800 metric tons. The others were electrolytic plants having a combined daily capacity of 56 metric tons. The largest was located at Cotrone, in Calabria; another at Monteponi, Sardinia; and the third at San Dalmazzo di Tenda, Piedmont. Although the combined capacity of these plants seems sufficient to supply the country's needs, apparently it has not been so in recent years, as, in keeping with the strong Government policy of national self-sufficiency, considerable effort has been expended to modernize the zinc and lead industries. In this connection a recent consular report from Rome is of interest.

It is stated that the smelters now in operation in Sardinia, at Cotrone, and at Vado Ligure will be able to produce about 20,000 metric tons of zinc during 1929. This is the tonnage annually consumed in Italy. Of this total 10,000 tons will be produced at Cotrone, 5,000 tons in Sardinia, and 5,000 at Vado Ligure. The production of zinc from additional smelters, construction of which might be contemplated, would imply competition between producers on the Italian market. This is not desired at present by Italian zinc companies. It is stated that when the Raibl zinc mines were granted about seven years ago to a British mining company the ore in sight was sufficient for eight years of operation. At present a tonnage sufficient for operation during the next eight years has been opened up in these mines through the exploration work carried on by the British Company. It is reported also that the zinc mines of Sardinia alone contain ample reserves of zinc ore to cover Italian needs both for peace and war time purposes.²³

The Società di Monteponi reported the production of 8,975 tons of lead ore, which was treated at the company's smelter at Monteponi, and 26,750 tons of zinc ore, part of which went to its Vado Ligure smelter; the rest was sold abroad. Metallic products of its works were 4,310 tons salable lead, 5,750 tons ordinary zinc, 3,260 tons electrolytic zinc, 1,650 tons zinc white, and 3,750 kilos silver.

During 1928 the Società di Pertusola²⁴ produced 8,430 tons of galena and 13,600 tons of calamine and decided to abandon for the time being some centers that are too poor to be worked at a profit in view of the slump in metal prices. To offset the resultant reduction in the tonnage of ore produced the company hopes to effect an improvement in the recovery of metal content by adopting the rotary-furnace process. With this in view, a 200-ton furnace for the production of

²³ U. S. Department of Commerce, Foreign Trade Notes, No. 231, Feb. 2, 1929.

²⁴ The Mining Journal (London) July 6, 1929, p. 558.

zinc oxide is to be erected at the San Giovanni mines, and it is expected that the installation will be ready by the end of 1929. The Cotrone electrolytic works are running, but the very delicate processes in operation there call for careful adjustment, to which the company is devoting close attention in collaboration with Anaconda, which controls the patents for the processes.

The Société Anonyme de la Vieille Montagne (Belgium) operates mines at Bergamo and in Sardinia, concerning which the following comments were made in the annual report of the company for 1928:

As far as the losses of our Italian mining agencies are concerned, we venture to recall what was reported on the subject last year; it arose from a double cause, viz, the increase in the value of the lira and simultaneously a fall in the value of the ores in regard to market quotations.

Further, the agencies were charged with outstanding taxes, which have been carried forward to the present financial year.

At Bergamo, we continue steps for the improvement of our mining plant, by the creation of special mills and hydroelectric power resources.

In Sardinia, we are developing the means of transport, resulting in considerable economy.

NETHERLANDS

The zinc-smelting industry in this country is supported entirely by foreign ores, of which 96,674 metric tons were imported in 1928. Production of zinc was 26,855 metric tons, a slight increase over 1927. Exports of slab zinc amounted to 27,094 tons.

NORWAY

Norway reported no zinc produced in 1928. Exports of crude zinc amounted to 2,100 tons. According to press reports the zinc industry of this country will soon be expanded. The Norwegian Zinc Co., in which French capital is interested, is building an electrolytic zinc plant near Odde. When completed the plant will have a maximum daily capacity of 100 short tons. French interests were reported as having obtained a concession to work zinc deposits at Mo, Ranen, northern Norway.

POLAND

Poland ranked third in production of zinc in 1928, with an output of nearly 162,000 metric tons or 11 per cent of the world total. The importance of this country as a zinc producer dates back to 1922, when it was awarded a part of German Upper Silesia, which contains one of the largest zinc deposits in the world. The part awarded to Poland contained all of the zinc smelters of this district and a large part of the mineralized area. At the close of the World War the Silesian zinc industry was largely controlled by German interests through the firm of Bergwerks Gesellschaft Georg von Giese's Erben and its subsidiary, Giese Spółka Akcyjna. The injection of a political boundary between some of the mines and the smelters of these companies caused operating troubles which, together with the rapid depreciation in value of securities they owned, soon brought the companies into financial difficulties. In 1925 the Anaconda Copper Mining Co., associated with the Harriman interests, entered into negotiations with the German companies looking toward possible participation in the reconstitution and financing of the latter. A temporary loan of \$10,000,000, adequately secured, was advanced, in

return for which the American interests were given a 6-month option within which to determine the extent to which they would participate in the reorganization of the German companies.

The American interests decided to exercise their option on the Polish properties only; and in July, 1926, the Silesian-American Corporation of Delaware was organized to acquire all of the issued capital stock of Giesche Spółka Akcyjna from von Giesche's Erben, together with \$6,000,000 of sinking-fund mortgage bonds on certain other properties of the latter company. In connection with this transaction the newly formed company issued \$15,000,000, 15-year, 7-per-cent collateral trust sinking-fund gold bonds. Giesche Spółka Akcyjna owns extensive zinc and coal deposits and smelters in Polish Silesia. A majority of both the preferred and common shares of Silesian-American Corporation were acquired by the Silesian Holding Co., and in this latter company the Anaconda Copper Mining Co. owns a majority stock interest so that actual control, as well as the management of the Polish enterprise, is held by Anaconda.

Under the new management many changes were made. Old plants were modernized, new plants for flotation, fire concentration of low-grade material, roasting, sintering, and electrolytic zinc were begun, and by the end of 1928 the greater part had been completed. The new electrolytic zinc plant of 50 metric tons daily capacity started operations at the end of the year.

In 1928 the subsidiary companies of the Silesian-American Corporation produced approximately 60,539 metric tons of zinc, or 37 per cent of the total Polish output, 6,329 tons of lead, 2,976,000 tons of coal, 103,590 tons of 60° B. sulphuric acid, and 67,360 tons of superphosphate and mixed fertilizers and manufactured large quantities of zinc sheets, zinc battery cups, lead sheets, pipe, shot, litharge, brick, and sundry other products.

From the date it was taken over by American interests to December 31, 1928, the Giesche Spółka Akcyjna expended nearly \$8,000,000 for new construction, plant modernization, and mine development.

Many changes were made in the operations of the other producing companies in 1928. In its prospectus concerning the issue of 96,000 new shares of 100 zloty each, the Schlesische A. G. für Bergbau und Zinkhüttenbetrieb (Ślaskie Kopalnie i Cynkownie, Spółka Akcyjna) of Lipine, Polish Upper Silesia, gave the following details regarding its properties.²⁵

Zinc mines.—The "Cecilie" mine covers an area of 1,911,304 square meters and is owned by a company 75 per cent of whose shares are held by Schlesische Bergbau und Zinkhüttenbetrieb. The mine installation includes a concentrator and an ore-washing plant. The concern also owns the "Jenny-Otto" ore-washing plant, at present idle.

Roasting furnaces and acid works.—The company owns plants at Lipine and Boguice (near Katowice).

Zinc smelters.—The Silesia zinc smelter at Lipine, the Kunigunde smelter (Boguice), and Rosamunde smelter (Nowy-Bytom) are all in operation, and an electrolytic plant with an annual output of 8,000 tons has been commenced.

Zinc oxide works.—Low grade zinc ores and slags are converted into zinc oxide in a new and up-to-date plant.

Zinc rolling mills.—The company owns the Silesia Rolling Works at Lipine, capable of handling its total output of spelter, also the Kunigunde Rolling Works at Myslowitz, which has about one-fourth the capacity of the Lipine plant and is at present idle.

²⁵ Metal Bulletin, London, Mar. 9, 1928, p. 10.

This same company is reported as heading an international consortium that acquired the zinc interests of the Henckel von Donnersmarck Beuthen Estates (Ltd.). The consortium, which is Franco-Belgo-German in composition, is said to include Giesche's Erben of Breslau (not of course Giesche Spółka Akcyjna of Katowice). The properties appear to have changed hands at a valuation of \$4,000,000. Schlesische Bergbau can now produce 4,500 tons of spelter monthly, which compares favorably with the Giesche Spółka Akcyjna. The plants acquired include the blende-roasting and zinc-smelting works of Lazyhütte (Radzionkau), the Hugo zinc smelter at Antonienhütte, and the idle Liebeshoffnungshütte, also at Antonienhütte. In view of the market position it is not likely that the latter or the Antonienhütte zinc-rolling mill will be restarted in the near future.²⁶

Further expansion of the Schlesische A. G. is reported to have included a lease from the Société des Charbonnages, Mines et Usines de Sosnowice, according to which this latter company for a period of 30 years has leased its Paulinen zinc smelter and its zinc ore mines to the first company, thus increasing the zinc output of that company by about 300 tons a month. The Schlesische company thus becomes the second largest producer in Europe, being exceeded only by the Vieille Montagne Co.²⁷ According to the American Bureau of Metal Statistics, Schlesische A. G., etc., produced 69,000 short tons of zinc in 1928.

Another large producer is the Hohenlohe Werke, which has been credited with a production of 29,500 tons in 1928. Following the example of the Giesche and the Schlesische concerns, this company contemplates erecting an electrolytic zinc plant to increase its output. The projected plant would permit treatment of low-grade zinc ores, resulting in the recovery of zinc and lead otherwise lost. To both the Schlesische and the Hohenlohe companies the problem of treating the lower-grade ores has vital importance, because since the World War fresh ore discoveries have been meager. The two companies have already begun to treat the low-grade ores and slimes (previously unusable) at special zinc oxide plants. Hohenlohe has enough 10 per cent slimes available to keep the zinc oxide plant (which turns out about 13 tons of oxide daily) busy for 40 years.²⁸

Labor conditions in Polish Silesia are reported as having been most unsatisfactory. Under the orders of the Polish Labor Minister the 8-hour day was to apply to skilled workmen in the Upper Silesian zinc smelters from September 1, 1928, and to all workers at the plants from October 1, 1928. It is reported that it has been very difficult for the operators to get the Polish labor unions to abide by wage or hour agreements for any length of time after said agreements were made.

Introduction of modern methods has greatly improved labor efficiency. Prior to American management of the Polish Bleischarley mine the output per man was only 10.6 tons of ore per month. In September, 1927, the output had increased to 21 tons per man.

²⁶ Metal Bulletin, London, Mar. 20, 1928, p. 17.

²⁷ Metal Bulletin, London, Sept. 14, 1928, p. 11.

²⁸ Metal Bulletin, London, Feb. 10, 1928, p. 17.

Political control of the zinc deposits in Polish and German Upper Silesia as of February, 1929, has been estimated as follows:²⁹

	Per cent
American.....	37
Franco-Belgian.....	30
Czechoslovak.....	15
British.....	12
German.....	6

Before the World War this region was almost entirely under German control.

The zinc produced in Poland is largely exported. The American Bureau of Metal Statistics reports the 1928 exports at approximately 125,000 metric tons, over half of which went to Germany. Czechoslovakia and Russia import substantial quantities of Polish zinc also. Zinc ore mined in German Upper Silesia is exported to Poland for smelting. In 1928 over 150,000 metric tons was thus exported.

RUSSIA

The American Bureau of Metal Statistics estimates the consumption of zinc in Russia in 1928 at 36,000 metric tons. Since only 4,300 tons was produced large imports were required. A similar situation existed with respect to other nonferrous metals; and the Soviet Government, desiring to overcome this situation, has made overtures to foreign capital to exploit its metal deposits. In June, 1928, it was reported that the Supreme Economic Council of U. S. S. R. had begun the erection of a zinc smelter in the Belovo district of the Siberian industrial area. The plant was to have an annual capacity of 12,000 tons of zinc and was to be completed in two years. Concentrates were to be drawn from the Salarski and Ridder mines.³⁰

Later in the year it was reported that the Government was considering erection of a 20,000-ton zinc smelter in the neighborhood of a new power plant on the Dnieper River. It was believed that enough ore to keep it in operation could be drawn from the Ural, Caucasus, Altai, and Nerchinsk areas. Whether the proposed plant was to use distillation or electrolytic methods was not known.³¹

The reports concerning the two zinc smelters have not been officially confirmed as yet.

The principal mining activity in 1928 was in the Tetiukhe and Altai districts. The Tetiukhe Mining Corporation, which in 1925 took over certain Russian lead-zinc-silver deposits from Selection Trust (Ltd.) and others, reported that during the year ended September 30, 1928, 47,302 metric tons of ore was treated, assaying 11.1 per cent lead and 14.8 per cent zinc. There were produced 12,886 tons of 45.3 per cent zinc concentrates and 6,797 tons of lead concentrates, assaying 71.9 per cent lead and 58 ounces silver. Ore reserves at the end of the year were estimated at 1,015,816 tons, averaging 8.1 ounces silver, 10.3 per cent lead, and 12.9 per cent zinc. In addition there was 99,000 tons of ore and tailings in dumps on the surface. The year's operation resulted in a loss of £28,628, making a total debit

²⁹ Metal Bulletin, London, Feb. 26, 1929, p. 17.

³⁰ Metal Bulletin, London, June 29, 1928, p. 17.

³¹ Metal Bulletin, London, June 29, 1928, p. 17.

balance of £53,291. An additional plant was built to enable the mill to treat 100,000 tons of ore annually.³²

The company planned to begin construction of a large lead smelter in 1928, in consideration of which the Soviet Government has granted a reduction in royalties, relief in custom duties, and unrestricted employment of a foreign technical staff. The mine is about 300 miles north of Vladivostok.

In the Altai district the Ridder mine was active and several thousand tons of concentrate and hand-picked ore was shipped to Germany via Leningrad. Apparently this property was under Government operation, but it was understood that the Urquhart interests were negotiating for repossession of this property and other Altai holdings that were confiscated by the Government in 1918.

In the North Caucasus the Alagir lead-zinc mine was being equipped with a flotation plant to treat complex ores.

SPAIN

In 1928 Spain produced ore containing about 45,000 metric tons of zinc. The smelter production was 13,549 tons, so that the principal part of the zinc mined in Spain was sent abroad for smelting, principally to France and Germany.

The depression in the price of zinc during the past few years has been a severe blow to the Spanish zinc producers. Deposits are widely dispersed geographically, and much of the ore is comparatively low grade. Plants were out of date and inefficient. During 1927 the situation became acute and the Government took steps to rehabilitate the industry by providing means for establishing modern mechanical equipment, flotation, adequate transportation, and a grouping of mines into efficient units. This program was progressing in 1928, but by July further regulation was deemed necessary and another royal decree was issued on July 27, 1928, which provided:³³

1. While the zinc mines in the Cartagena-La Union zone are being organized to conform to the plan under way for the introduction of efficient and up-to-date mining methods, the firms and individuals forming the Sindicato Minero de Cartagena-Mazarrón will be required to deliver all their production of zinc ore to the mentioned Syndicate in accordance with the provisions of the royal decree of October 4, 1927.

2. The Sindicato Minero de Cartagena-Mazarrón, in pursuance of the powers with which it is vested by royal decree No. 975, of May 28, 1927, may obtain from the Banco de Credito Industrial cash loans up to the total amount of 1,500,000 pesetas, such loans to be employed for the exercise of its functions as defined by the decree last mentioned, particularly for the purchase and smelting of zinc ore and its transportation to points of sale in the domestic or foreign markets.

3. In order to compensate the syndicate for the losses that may arise in its purchases of zinc ore in case the low quotations in the European zinc market subsist for a longer period than the warehousing of the ore could reasonably withstand, the Spanish Government will make advances of cash up to a total amount not to exceed 250,000 pesetas chargeable against the general fund for the protection of industries created by the decree law of April 30, 1924. These cash advances will be made by the Government to enable the syndicate to pay off its debt to the Banco de Credito Industrial, and with the prime object of obviating a closing down of the mines in the event of the described contingency.

³² Mining Magazine, London, vol. 41, September 1929, p. 192.

³³ U. S. Department of Commerce, Foreign Trade Notes, No. 215, Oct. 13, 1928.

SWEDEN

Sweden produced 5,106 metric tons of zinc in 1928 and exported 34,545 tons of ore. Mine production was curtailed somewhat by labor troubles. The Vieille Montagne, which operates mines and a zinc-roasting plant in Sweden, reported that during 1928 these plants were idle seven months of the year as a result of a lockout.

YUGOSLAVIA

This country produced 4,883 metric tons of zinc in 1928, which was largely derived from foreign ores of which 10,553 tons was imported, chiefly from Italy. About 3,000 tons of crude zinc was exported.

Particulars of the Trepca Mines (Ltd.), one of the Selection Trust group, are now available. This company was formed in 1927 to acquire the Trepca mining concession and other mining rights and has devoted special attention to the Stantrg lead-zinc-silver deposit, which is situated five miles east of the town of Kosovska Mitrovica, and about 200 miles north of Salonika. The ore-body is a replacement in limestone and it has been developed by means of adits. It is estimated that 1,750,000 tons of ore has been proved or indicated, averaging 11.5 per cent lead, 10.5 per cent zinc, and 3 ounces silver per ton. Last month 1,600,000 shares of 5s. each were subscribed at par, the funds being required for a concentrating plant with a capacity of 500 tons per day.³⁴

AFRICA

ALGERIA

Algeria has been an important producer of zinc ores for many years, but recently production has been on the decline. Official figures for 1928 give a production of about 35,000 tons of ore, 27 per cent less than in 1927. The ore is smelted in Europe. Unsatisfactory conditions are indicated by the following article:

It is complained that the existence of some of the Algerian mines, situated far from the coast, will be gravely threatened by the proposed increase in railway rates, as various categories of ore will then cease to be remunerative. The growing lack of native labor, aggravated by the withdrawal of military prison labor from outdoor work, and facilitated by the lax emigration control and increasing fiscal charges, are already threatening the industry. It is declared by Algerian mining interests that instead of the administration encouraging the rapid development of the country's mineral wealth, powerful companies like the Royale Asturienne des Mines, are being discouraged, and are in consequence checking operations in Algeria to transfer their activities to Tunisia and Morocco.³⁵

RHODESIA

Rhodesia became an important producer of zinc for the first time in 1928, when operations were begun at the electrolytic zinc plant of the Rhodesia Broken Hill Development Co. (Ltd.). The company's mine is on the main railway line through Northern Rhodesia. It is 1,330 miles by rail from the port of Beira and 374 miles from Victoria Falls.

The ore occurs as a replacement of dolomite along more or less vertical bedding planes and fissures. Oxide minerals, including the silicate and carbonate of zinc, carbonate and chlor-phosphate of lead, and lead-zinc vanadates, occur in the upper portions of the deposits. Below 100 feet galena and blende are present.

³⁴ Mining Magazine, London, vol. 41, August, 1929, p. 72.

³⁵ Metal Bulletin, London, July 17, 1928, p. 18.

Commercial production of lead began in 1916 and there are now four 150-ton blast furnaces and a 300-ton concentrator for separating the lead and zinc sulphides on the property.

The new zinc plant (maximum daily capacity, 60 short tons of cathode zinc) began operations in January, 1928. Acid consumption proved to be higher than anticipated, and an extension to the acid plant became necessary. Zinc production was also handicapped by a shortage of power, and steps were taken to increase the capacity of the company's hydroelectric plant at Malungushi. During the year the company produced 9,579 long tons of zinc and 4,676 tons of lead. When present improvements are completed the production of zinc is expected to reach 1,500 tons per month. The company sold a small quantity of vanadium ore and present plans call for completion of the plant for producing ferrovanadium, which was started some time ago but delayed to permit completion of the zinc plant.

At the annual meeting of the company in July, 1928, it was stated that the proved zinc ore reserves amounted to over 1,000,000 tons, assaying 30 per cent zinc, 8 per cent lead, and 0.9 per cent vanadium oxide. In addition, there were 200,000 tons of slag averaging 18 per cent zinc, 4.2 per cent lead, and 1.2 per cent vanadium oxide. Lead and vanadium are recovered as by-products of the zinc plant.

The Base Metals of Northern Rhodesia (Ltd.) operates a property northwest of Lusaka and 70 miles from Broken Hill. During 1928 the company contracted to supply 72,000 tons of zinc ore (three years at 2,000 tons per month) to a Johannesburg firm. The ore, which averages 47 to 48 per cent metallic zinc, was being quarried out of a solid kopje of mineral and is shipped without treatment. A zinc smelter is being considered.³⁶

The Copper Queen and Copper King properties of the Southern Rhodesia Base Metals Corporation (Ltd.) did not fulfill expectations and have been abandoned. Nearly \$1,000,000 was expended in development work. On the Copper Queen only 474,000 tons was developed, assaying 2.3 per cent copper, 2.2 per cent lead, and 4.7 per cent zinc, while on the Copper King 335,000 tons of ore averaging 3 per cent copper, 1.5 per cent lead, and 5 per cent zinc was developed. This was too low grade under present market prices to warrant the capital requirements for development.³⁷

TUNISIA

Production of zinc ore in Tunisia has declined during the past three years. In 1928 ore containing 3,500 metric tons of zinc was produced, only 34 per cent of the 1926 output. According to the *Écho des Mines* this has been due to the development of American production, the exhaustion of the oldest and most extensive deposits, and the decline in grade of ore, unsatisfactory selling formulas, labor shortage, and increased cost of transportation. Some attempt at relief has been made by the Government in the form of a reduced tax on prospecting permits and a proposal to reduce freight rates on low-grade ores.

Tunisia has no zinc-reduction works, but early in 1928 it was reported that the *Société des Exploitations Minières en Tunisie* had

³⁶ South African Mining and Engineering Journal, vol. 39, Feb. 9, 1929, p. 604.

³⁷ Engineering and Mining Journal, vol. 126, Sept. 29, 1928, p. 506.

decided to build an electrolytic plant near Touireuf. The company would have to depend on custom ores to some extent, and this, together with an adequate supply of labor, would be essential to a profitable undertaking. The actual erection of this plant has not been reported as yet. Later reports stated that the company was to build a plant using the Coley process. It is not known to the writer whether this plant is to take the place of or be an auxiliary to the electrolytic plant.

Peñarroya has acquired a lease on the Djebel Ressay property near Tunis, and extensive prospecting is being carried out.

OCEANIA

AUSTRALIA

In 1928 Australia ranked third in mine production of zinc with an output of about 150,000 metric tons of zinc. About two-thirds of the output is usually shipped to European smelters and one-third treated at the electrolytic zinc plant at Risdon, Tasmania, where about 51,000 tons of zinc was produced in 1928. About 36,000 metric tons of zinc was exported, of which Japan took 45 per cent, Great Britain 29 per cent, and Germany 25 per cent.

New South Wales.—Virtually all of the zinc production of Australia is derived from the lead-silver deposits of Broken Hill, New South Wales. During the last few years this district has suffered from low metal prices and adverse labor conditions. The earnings of all companies have been materially reduced, and some properties are unable to operate profitably under present conditions. The principal producers in 1928 were the North Broken Hill (Ltd.), Broken Hill South (Ltd.), Zinc Corporation (Ltd.), and Sulphide Corporation (Ltd.).

During 1928 the Zinc Corporation increased its output and treated 274,371 long tons of ore carrying 15.7 per cent lead, 3.4 ounces silver, and 10.6 per cent zinc and produced 62,215 tons of lead concentrates and 48,713 tons of zinc concentrates. The former ran 65.1 per cent in lead, 13.6 ounces in silver, and 6.6 per cent in zinc, while the latter contained 48.2 per cent zinc, 3.4 per cent lead and 1.4 ounces silver. Improved metallurgical recoveries and reduced costs were achieved during the year. Ore reserves, as of December 31, 1928, were 2,666,800 tons of lead-zinc ore and 245,969 tons of zinc-lead ore. The metal content was not reported, but as of December 31, 1927, the lead-zinc ore reserves averaged 14.6 per cent lead, 10.7 per cent zinc, and 3.1 ounces silver, while zinc-lead ore contained 18.1 per cent zinc, 6.4 per cent lead, and 1.4 ounces silver.

For the year ended June 30, 1928, the Sulphide Corporation reported treatment of 134,638 tons of ore and 28,578 tons of dump slime, resulting in the production of 39,494 tons of zinc concentrates and 27,683 tons of lead concentrates. The former ran 49.5 per cent zinc, 5.3 per cent lead, and 8.6 ounces silver while the latter contained 63.7 per cent lead, 9.9 per cent zinc, and 50.5 ounces silver. Low metal prices necessitated a shutdown of the Junction mine in September, 1927. The company formerly operated a lead smelter at Cockle Creek, which was discontinued when the Port Pirie lead smelter became available. Zinc concentrates are now roasted at Cockle Creek before shipment to the electrolytic plant at Risdon. Sulphuric acid is produced and used in the manufacture of superphosphates.

Cement is also being produced. The Cockle Creek phase of the company's activities is making rapid progress.

The mine of the Broken Hill Proprietary Co. (Ltd.), formerly an important producer, was shut down in September, 1927, due to low metal prices and unfavorable labor conditions. At the annual meeting of the company in August, 1928, it was stated that notwithstanding the fact that a few years' life remained in the property under favorable conditions the company would soon have to face the issue of finally closing down the mine, as it would be uneconomical to keep the property open indefinitely. However, in July, 1929, it was announced³⁸ that this mine would be operated through the Central mine of the Sulphide Corporation and the ore would be treated in that company's mill. A similar announcement was made concerning the Block 14 mine of the Broken Hill Proprietary Block 14 Co. (Ltd.) which has been idle for some time.

North Broken Hill Co. reported that during the year ended June 30, 1928, 422,181 tons of ore was sent to the mill, averaging 13.6 per cent lead, 10.5 per cent zinc, and 7.8 ounces silver per ton, and that 79,373 tons of lead concentrates was produced, averaging 64.9 per cent lead, 7.8 per cent zinc, and 32.3 ounces silver, together with 73,054 tons of zinc concentrates averaging 47.5 per cent zinc, 5.1 per cent lead, and 6.4 ounces silver. In addition, 85,391 tons of dump slime, averaging 9.7 per cent lead, 15.2 per cent zinc, and 7.7 ounces silver, was treated; this yielded 10,355 tons of lead concentrates, averaging 59.4 per cent lead, 12.2 per cent zinc, and 43.3 ounces silver, and 23,727 tons of zinc concentrates, averaging 46.2 per cent zinc, 5.5 per cent lead, and 5.8 ounces silver.³⁹ Ore reserves are estimated at approximately 4,000,000 tons.

Broken Hill South reported that during the year ended June 30, 1928, 336,280 tons of ore was sent to the mill, averaging 13.7 per cent lead, 10.8 per cent zinc, and 5.2 ounces silver per ton. The output was as follows: 65,523 tons of lead concentrates averaging 65.6 per cent lead, 6.5 per cent zinc, and 23.6 ounces silver, and 58,363 tons of zinc concentrates, averaging 49.3 per cent zinc, 2.6 per cent lead, and 2 ounces silver. The amount of ore treated was slightly greater than the year before, and there has been a continued improvement in concentration practice. The ore reserve was estimated at 4,250,000 tons.⁴⁰

Tasmania.—The Electrolytic Zinc Co. of Australasia (Ltd.), in which a large interest is owned by the principal producers at Broken Hill, operates an electrolytic zinc plant at Risdon, with a maximum daily capacity of 142 long tons of cathode zinc. In the year ended June 30, 1928, the company produced 49,117 long tons of zinc and returned residues containing 7,340 tons of lead and 994,000 ounces of silver to the smelters at Port Pirie. In addition 162 tons of cadmium was extracted, together with residues containing 229 tons of copper. The company is developing the Read-Rosebery lead-zinc-silver deposits. A new mill is being erected at Rosebery to handle 100,000 tons annually. Production of zinc concentrates is expected in 1930.

Queensland.—As a result of developments in the Mount Isa field this Province is destined to become an important producer of lead,

³⁸ Engineering and Mining Journal, vol. 128, July 13, 1929, p. 72.

³⁹ Mining Magazine, London, vol. 39, November, 1928, p. 269.

⁴⁰ Mining Magazine, London, vol. 40, January, 1929, p. 66.

zinc, and silver. The Mount Isa field is situated in the northwest part of the Province, 60 miles west of Cloncurry and 500 miles by rail from the nearest port, Townsville. The ore bodies, which occur as replacements and veins in an old series of altered sediments, were discovered in February, 1923. The outcrops contained high-grade lead-silver carbonate ore, and several companies were soon shipping ore by motor trucks to the railroad at Dutchess, about 60 miles southeast. It soon became apparent that the nature of the deposits necessitated large-scale operations, and by 1926 the Mount Isa Mines (Ltd.) had acquired control of virtually the entire district. By the end of 1926 additional capital was needed. The capitalization of the company was increased, and the Anglo-American Corporation acquired an option on a large block of stock. After examination of the property the option was relinquished in July, 1927. Shortly after, the Russo-Asiatic Consolidated (Ltd.) purchased a controlling interest in Mount Isa Mines (Ltd.), and since then the property has been developed for production rapidly.

On January 16, 1929, the company announced ore reserves as of November 29, 1928, as follows: Carbonate ore, 3,500,000 tons, averaging 9 per cent lead and 3.6 ounces silver per ton; sulphide ore, assured to the 750-foot level, 12,200,000 tons averaging 6.1 per cent lead, 8.2 per cent zinc, and 3.7 ounces silver; 5,000,000 tons of additional sulphide ore of same assay expected above the 750-foot level; and in addition approximately 500,000 tons of sulphide ore of much higher grade.⁴¹ As the deposit is still being prospected actively, additions to the above amounts will no doubt be made.

A 54-mile branch railroad from Dutchess was completed in April, 1929. A mill is under way and will eventually treat 2,000 tons of ore per day. A lead smelter is also being built at the mine, which will manufacture a lead-silver bullion from the lead concentrates produced in the mill. No provision for treating the zinc concentrates has been announced as yet, but the company contemplates erection of an electrolytic zinc plant in Queensland if a satisfactory source of power is available. Power for the mines, mill, and smelter will be supplied by two 5,000-kilowatt turbo steam sets operating on coal dust. A dam has been built at Rifle Creek, 20 miles from the mine, which will provide water for the operation by impounding the run-off during the rainy season.

Mining costs have been estimated at less than 2s. per ton of carbonate ore and 5s. per ton of sulphide ore. Milling costs have been estimated at 5s. per ton. The first unit of the mill will operate on carbonate ore and with lead at £20 a ton and silver at 2s. an ounce profits are expected to be about 30s. per ton of ore treated.⁴¹

NEW ZEALAND

The following note concerning a new attempt to exploit the Mount Zeehan property is of interest:

The Waiomo Sulphide Corporation (Ltd.), a new company, was registered recently with a capital of £50,000, divided into 200,000 shares at 5s. each. The object of this company is to acquire an area of ground of 590 acres in extent, together with the plant on property. This property was formerly known as the Mount Zeehan, situated in the Waiomo district, which lies about 9 miles north-west of the old Thames gold field. It is well known that a mineral belt awaits

⁴¹ Engineering and Mining Journal, vol. 127, Feb. 9, 1929, p. 253.

development here, the ores requiring special treatment, and the plant to be employed will be Minerals Separation and De Bavay's oil flotation process for the concentration of metals.

The previous company who erected a plant had to suspend operations, due to the want of the required capital to carry out the completion of the plant. Judging by the personnel of the board of directors, the names of distinguished mining engineers thereon is a sufficient guarantee that the value of the mine, with its complex minerals, has attracted them. The writer is much impressed with this part of our gold fields and believes that this company will meet with considerable success. The whole failure of the past by those who attempted to develop the property and treat the ores was the difficulty of treating the complex ores, which contained gold, silver, copper, zinc, and lead. It is claimed by this new company that this difficulty will be overcome in the new plant that the company are now installing.

It may be worth mentioning that there is a vast field in this district practically unexplored, which will no doubt receive attention if this new company's plant succeeds in overcoming the metallurgical difficulties. The company state that the completion of the new plant will be made in about four months; in the meantime the mine will be vigorously developed and placed in a thoroughly productive condition.⁴³

ASIA

INDIA

The Burma Corporation (Ltd.) is one of the world's important lead-zinc producers and the only producer of any consequence in India. Its mines are at Bawdwin in the Upper Shan States of Burma. During the year ended June 30, 1928, the company mined 429,845 long tons of ore containing 23.5 per cent lead, 21.5 ounces silver, 14.9 per cent zinc, and 1.3 per cent copper. At the mill 58,222 tons of zinc concentrates was produced, with an average content of 50.49 per cent zinc, 6.48 per cent lead, and 11.29 ounces of silver. Only 55 per cent of the zinc in the ore treated was recovered in the zinc concentrates, owing to the refractory nature of the ore. At the lead smelter 72,388 tons of refined lead and 6,954,665 ounces of refined silver were produced, as well as 12,388 tons of copper matte and 773 tons of refined antimonial lead. Improvements in smelting practice resulted in production for the first time of a copper-nickel speiss. Ore reserves, as of June 30, 1928, were estimated at 4,092,751 tons assaying 21.5 ounces silver, 25.9 per cent lead, and 16 per cent zinc.⁴⁴

INDO-CHINA

Capital employed in mining ventures in Indo-China is mostly French, and recent legislation with regard to the granting of concessions there to foreign interests will make the entry of foreign capital more difficult than heretofore.⁴⁵ The Campagnie Minière et Métallurgique de l'Indo-Chine, the principal operator in the country, reported that, in 1928, 38,680 metric tons of salable ore was produced. About 31,300 tons was exported, mostly to Europe, while 2,900 tons was shipped to Japan. About 9,800 tons was delivered to the company's smelter at Quang Yen, where 2,887 tons of zinc was produced. This increase resulted from the starting of new furnaces at the smelter.

⁴³ Mining Journal, London, vol. 164, Mar. 30, 1929, p. 244.

⁴⁴ Annual report of the Burma Corporation (Ltd.) for the year ended June 30, 1928

⁴⁵ Engineering and Mining Journal, vol. 127, Jan. 19, 1929, p. 128.

JAPAN

Japan produced about 19,000 metric tons of zinc in 1928. The American Bureau of Metal Statistics estimated the consumption at 54,800 tons. Imports in 1928 were reported at 35,759 tons, of which Canada supplied 34 per cent; Australia, 34 per cent; United States, 25 per cent; and others, 7 per cent.

A summary of the zinc industry in Japan was recently published by the *Daily Metal Reporter*.⁴⁶

The galvanizing trade is, of course, the largest consumer of zinc, and second in importance is the brass industry. The chief galvanizing works are located in Osaka and Tokio and include the Nippon Galvanizing Works, Kansai Galvanizing Works, the Osaka Teppan Works, and the Tokio Galvanizing Works. Most of the brass manufacturers have their plants in Kyoto and Osaka. The brass makers have always shown a decided preference for electrolytic zinc, whereas the galvanizers use electrolytic zinc but mix it with 98.5 per cent zinc. This 98.5 per cent zinc is produced by Mitsui Mining Company, and sold through Mitsui & Company. When the Suzuki Company went out of business, Mitsui Mining Company bought its Hikoshima mill, located at north of Kyushu Island. Mitsui Mining Company also has a plant on the same island known as the Miike plant. Japan owns her own zinc ore, but whenever the foreign price is sufficiently attractive Japan imports zinc concentrates from America and Mexico. The zinc ore supplies at Korea, China, and French Indo-China are more frequently drawn upon. There is every reason to believe that in the near future, Japan will increase its production of slab zinc, because the Mitsui Mining Company is going to expand its production of 98.5 per cent zinc.

EUROPEAN ZINC CARTEL

Zinc and bismuth share the distinction of being the first metals for regulating production of which an international cartel was organized. In 1885, German and Belgian producers came to an agreement on production quotas for the first time. Subsequently there were several reorganizations, and just prior to the World War the cartel was largely dominated by the German metal trio, Beer Sondheimer & Co., the Metallgesellschaft, and Aaron Hirsch & Son. By the end of the war the international aspects of the cartel disappeared and only an association of German producers remained, which dissolved early in 1927.

Depression of the industry that followed the decline in price during 1926 and 1927 provided the incentive for reconstitution of the cartel, which was finally accomplished under the leadership of the Société Anonyme de la Vieille Montagne, of Belgium, on May 7, 1928. At a meeting in Brussels plans were perfected for formation of the cartel. According to the *Metal Industry*,⁴⁷ results of the meeting were as follows:

It is now stated that the European Zinc Cartel has been formed for a period of six months as from May 1. Members must notify their withdrawal, if such is desired at any time, at least two months before the expiry of the agreement, and in the present instance the cartel can not be denounced before October 1, 1928. The central bureau is located provisionally at the Brussels office of the Vieille Montagne Co., 23 Rue Belliard, Brussels, the president being St. Paul de Sincay of that concern. Every two months a statistical review will be drawn up dealing with production and stocks, including remelted zinc and zinc dust. With the help of this report measures will be taken every four months to regulate production. At present there is no question of price control being introduced. It is stated that 95 per cent of the European spelter production was represented

⁴⁶ *Daily Metal Reporter*, vol. 28, No. 201, October, 1928, p. 8.

⁴⁷ *Metal Industry*, London, May 15, 1928, p. 17.

at the meeting. Belgium was represented by the Vieille Montagne Co. and the Union des Usines à Zinc; Holland by Zines de la Campine; France by Asturienne, Montagne, Peñarroya and the French branch of Vieille-Montagne; Germany by a delegate of the zinc smelters; Poland by Oberschlesische Zinc, Giesche and Hohenlohe; England by several representatives of the smelters, and Spain by Asturienne and Peñarroya, which latter also partly represented Italy, whilst Norway also sent delegates. America, too, was represented and was in consultation with the president regarding the conditions under which the United States could join the scheme.

As outlined above, the cartel amounted to no more than a statistical bureau, as there was no agreement as to price stabilization, stocks, or production control. Continued decline in the London price of zinc and increasing stocks in Europe finally resulted in the cartel taking definite action in the latter part of the year. Details of the cartel's activities apparently have not been announced officially, and various press reports differ somewhat. The following chronology of events up to October, 1929, is based largely on reports appearing in the London Mining Journal and Metal Bulletin, also of London.

November, 1928. Meeting between representatives of European zinc cartel and American producers reported to have taken place in New York. No results announced.

December 11, 1928. Belgium, Great Britain, France, and Poland were represented at a meeting in which it was agreed to extend the cartel agreement to June 30, 1929. The following proposal was made, subject to approval by the boards of the companies concerned. Effective January 1, 1929, output was to be curtailed 7 per cent until the London price of zinc became stabilized at £27 for one month. Periodic conferences were arranged to review the zinc market and to assist in maintaining the equilibrium of European production and consumption. Principal overseas producers were reported as having agreed to curtail their exports to Europe by a like amount. European production of high-grade electrolytic zinc apparently was not included in the restriction. In view of the new unrestricted electrolytic zinc production of Giesche (Anaconda) it was agreed that their output of ordinary zinc was to be cut 17 per cent. It was reported that in anticipation of the cartel's action the price of zinc had increased from £23 17s. 6d. on November 1 to £26 17s. 6d. on December 31.

January 4, 1929. George S. Brooks, managing director of Giesche Spółka Akcyjna, was reported as having stated that no agreement whereby American producers have joined an European cartel either as regards their home market or a suspension of zinc exports has been arranged, as this would be impossible under the American antitrust laws. He was reported as having confirmed the report of a general agreement with regard to the regulation of the European zinc market with which various overseas producers, including the Australians and Canadians, have declared themselves in accord.

January 5. Official ratification of cartel agreement by all members completed.

January price of spot zinc, London, averaged £26.196.

February 1. It was reported that the cartel had increased curtailment from 7 per cent to 10 per cent for February and March.

March 8. At a meeting on this date it was reported that, effective April 1, curtailment would be reduced from 10 to 7 per cent. The clause in the agreement fixing the price limit at which works may resume their liberty of action as regards output was canceled. The new decision was to operate only for the months of April, May, and June.

Average price in London for March was over £27.

April 25. Curtailment was again reduced from 7 to 5 per cent effective for May and June. It was reported that some producers favored abandoning production control in view of the improvement in the zinc market. In view of the fact that the cartel did not include a large number of ore producers it was believed that the custom smelters had not benefited by the curtailment as had the smelters owning their own mines.

April price of spot zinc, London, averaged £26.759.

May 3. Future reduction of curtailment in sight owing to a substantial decline in stocks and anticipated consumption due to a revival of building activity.

June 6. Cartel decided to maintain the 5 per cent restriction until September 30.

June 22. The Mining Journal, London, reported the following official communication: "The cartel agreement, which runs up to June 30, has been extended from July 1 for one year. So far as production limitation is concerned, the delegates have agreed on the following basis: (1) When the price of zinc reaches £27 per ton, or exceeds it, no limitation of production by the members is to apply unless the increase in production, in relation to the average production, of the last three months exceeds 10 per cent; (2) if the price of zinc does not reach £27 and if the European stocks simultaneously amount to 30,000 tons or more, then limitation of production comes into force automatically."

June price of zinc, London, averaged £26.216.

July 8. In view of declining zinc prices curtailment was increased from 5 per cent to 10 per cent effective August 1 to September 30.

Average price for July was £25.332.

August. Polish producers were reported as being dissatisfied with 10 per cent curtailment, as it had seriously decreased their output of sulphuric acid, for which there was a good market. Later it was reported that this matter had been adjusted.

Average price for August was £24.896.

September 12. Meeting of cartel confirmed decisions of July 8 and extended 10 per cent curtailment policy to end of year. Next meeting was set for November 19, when renewal of cartel and 1930 rate of production would be considered.

Average price for September was £24.208.

IMPORTS

The chief zinc import of the United States is zinc ore. The zinc content of imported ore was reported at 1,667 tons and the net reduction in warehouse stocks was reported as 1,784 tons. These figures indicate a maximum zinc content of 3,451 tons in foreign ore made available for smelting in 1928. Smelters, however, have reported the production of 11,056 tons of zinc from foreign ores. The discrepancy between the 3,451 tons and 11,056 tons is believed to be too large to be explained by stocks of ores at smelters. The following table gives the Bureau of Foreign and Domestic Commerce record of zinc ore imported into the United States from 1919 to 1928. The figures must be taken as subject to material revision when the reason for discrepancy between the warehouse record and smelter production shall have been disclosed.

Zinc ore imported into the United States, 1919-1928, in short tons

[General imports]

Year	Canada		Mexico		Other countries		Total	
	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content	Ore	Zinc content
1919.....	10,656	3,878	33,443	11,225	4,550	1,906	48,649	17,009
1920.....	4,731	1,794	47,453	14,975	13,589	5,718	65,773	22,487
1921.....	1,471	554	6,050	2,147	18	4	7,539	2,705
1922.....	(1)	235	(1)	1,665	(1)	29	(1)	1,929
1923.....	(1)	4	(1)	3,201	(1)	18	(1)	3,223
1924.....	-----	-----	(1)	4,649	-----	-----	(1)	4,649
1925.....	(1)	3,894	(1)	9,607	(1)	35	(1)	13,536
1926.....	(1)	2,281	(1)	12,265	(1)	21	(1)	14,567
1927.....	(1)	217	(1)	9,285	(1)	11	(1)	9,513
1928 ¹	(1)	18	(1)	1,646	(1)	3	(1)	1,667

¹ Gross weight not recorded.

² Figures probably incomplete. See preceding paragraph.

A large part of the zinc ore imported into the United States is entered for warehouse to permit smelting and reexport of the metallic

zinc free of United States import duties. The following table shows the zinc remaining in warehouse in the United States at the end of each year, 1919 to 1928, inclusive:

Zinc remaining in warehouse in the United States, December 31, 1919-1928

Year	Ore and calamine		Blocks, pigs, and old		Zinc dust	
	Zinc content (pounds)	Value	Pounds	Value	Pounds	Value
1919.....	37,696,007	\$674,384				
1920.....	51,299,109	996,386				
1921.....	28,583,018	647,654	262,221	\$10,911		
1922.....			160,976	6,396		
1923.....	1,736,874	84,977	160,976	6,396	12,048	¹ \$256
1924.....	12,103,110	494,605			1,998	138
1925.....	40,938,685	1,936,332				
1926.....	27,580,974	1,331,318				
1927.....	12,287,023	592,206				
1928.....	8,719,290	797,923				

¹ Includes manufactures of zinc.

The United States imports very little slab zinc, rolled zinc, and manufactured zinc products. In 1928 the total value of these imports was \$132,813, of which \$115,784 represented the value of manufactured products. A considerable amount of old brass is imported, chiefly from Canada. In 1928 that country supplied 88 per cent of the total imports.

Zinc imported for consumption in the United States, 1919-1928

Year	Blocks or pigs		Sheets		Old		Zinc dust		Value of manufactures	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1919.....	32	\$2,284	1	\$249	37	\$2,216	52	\$5,753	\$1,258	\$11,760
1920.....	(¹)	17	4	614	14	1,065	17	6,207	1,746	9,649
1921.....	6,598	559,870	6,688	496,445	6	341	42	1,121	8,290	1,066,067
1922.....	40	3,327	416	59,037	46	2,403	79	5,614	9,517	79,898
1923.....	1	375	(¹)	41	20	1,624	4	891	16,331	19,262
1924.....	11	1,973	(¹)	88	14	1,493	59	9,241	20,089	32,884
1925.....	(¹)	303	(¹)	55	24	2,495	116	20,936	18,979	42,768
1926.....	(¹)	195	(¹)	46	21	1,315	2	451	44,574	46,581
1927.....	39	5,089	1	271	19	1,443	(¹)	114	91,519	98,436
1928.....	(¹)	66	3	2,556	3	260	146	14,147	115,784	132,813

¹ Less than 1 ton.

Old brass, fit only for remanufacture, imported into the United States, 1919-1928

[General imports; average composition about one-third zinc and two-thirds copper]

Year	Short tons	Value	Year	Short tons	Value
1919.....	7,938	\$2,157,948	1924.....	4,636	\$698,022
1920.....	22,355	5,174,885	1925.....	5,374	772,906
1921.....	20,449	2,373,082	1926.....	4,311	631,973
1922.....	71,962	10,985,308	1927.....	3,993	556,064
1923.....	20,395	3,992,917	1928.....	6,075	1,015,172

EXPORTS

The total value of the 1928 exports of zinc ore and domestic and foreign manufactures of zinc (not including galvanized products, alloys, and pigments) amounted to approximately \$4,600,000, representing decreases of about 50 per cent from 1927 and about 75 per cent from the recent high in 1925.

For many years slab zinc has been the largest single item of zinc exports, and in 1928 it accounted for 65 per cent of the total value. Over 25,000 tons (mostly high-grade zinc), valued at about \$3,000,000, was exported in 1928, a decrease of 45 per cent in quantity and 50 per cent in value from 1927. Exports of slab zinc have declined 67 per cent since 1925, probably due to increased production in Europe and to the inability of American producers to compete in European markets under the low price of zinc prevailing during the last few years. In 1925 Europe took 93 per cent of the total slab-zinc exports, whereas in 1928 she took only 53 per cent, or 13,527 tons. Exports to Europe in 1927 were 30,729 tons or 67 per cent of the total. This large decrease was largely the result of marked falling off in the exports to United Kingdom, which took 1,152 tons in 1928, as compared to 20,518 tons in 1927. Exports to Germany more than doubled, and France took about one-third more in 1928 than in 1927. Exports to South America decreased from over 5,000 tons in 1927 to 713 tons in 1928, because Argentina took only 30 tons, as compared to over 4,000 tons in 1927. Exports to Asia increased 15 per cent. As usual, Japan was the largest customer, having taken practically all of the exports to Asia.

Plates and sheets were the second largest item of the United States zinc-export trade in 1928 and increased 10 per cent over 1927. Canada and the United Kingdom were the principal recipients and each increased its shipments in 1928. Canada received 43 per cent of the total United States export and United Kingdom 32 per cent.

Exports of zinc ore and concentrates in 1928, as in 1927, decreased tremendously, and only 4,518 tons was exported, as compared with 46,716 tons in 1927 and 95,252 tons in 1926. Data are not available showing the source of exported ore by mining districts or States, but the following table shows the distribution by customs districts from which the ore was exported.

Domestic zinc ores and concentrates exported from the United States, 1926-1928, by customs districts, in short tons

District	1926	1927	1928	District	1926	1927	1928
New York	3, 622		300	Oregon	25, 209	15, 802	
Buffalo		81		Philadelphia		7	
Dakota	1			St. Lawrence	6		
Galveston	5, 872	1, 902		San Francisco	17, 889	10, 538	2, 196
Los Angeles	3, 527	1, 782		Washington	2, 076	1, 523	130
Michigan		37					
New Orleans	37, 050	15, 014	1, 892		95, 252	46, 716	4, 518

Belgium took only 532 tons in 1928 as compared to 28,525 tons in 1927, and France took 1,892 tons in 1928 and 14,128 tons in 1927. The decrease in exports of zinc ore in recent years was probably due to the low price of zinc in European markets, under which the customary European formula for buying zinc ore did not yield a large

enough premium over American ore prices to offset the cost of transportation to European ports.

Exports of zinc dross in 1928 decreased 29 per cent in quantity and 19 per cent in value as compared with 1927. Belgium, United Kingdom, and Germany were the principal customers in 1927, having taken 81 per cent of the total.

Exports of zinc dust amounted to 1,008 tons in 1928, as compared with 1,357 tons in 1927. Mexico took 62 per cent of the total in 1927 and in 1928.

There was a slight increase in the total value of brass and brass manufactures exported in 1928.

Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1919-1928

Year	Zinc ore and concentrates		Pigs or slabs		Plates and sheets		Zinc dross		Zinc dust	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919.....			109,746	\$17,524,153	19,762	\$5,212,002	5,123	\$739,295	(1)	(1)
1920.....			74,046	12,495,144	11,852	2,832,993	2,445	316,637	(1)	(1)
1921.....			1,753	204,984	1,816	425,618	510	45,340	(1)	(1)
1922.....	1,695	\$33,592	26,815	2,994,625	3,217	574,491	8,412	662,080	1,998	\$287,890
1923.....	² 2,804	(2)	42,131	5,961,525	3,732	764,369	³ 14,745	³ 1,221,986	3,679	507,289
1924.....	² 368	(2)	⁴ 72,583	⁴ 9,538,459	3,658	784,728	³ 10,845	³ 974,179	2,270	353,867
1925.....	68,951	3,277,118	⁴ 76,351	⁴ 11,654,441	4,196	926,841	15,968	1,567,697	2,242	408,017
1926.....	95,252	4,056,067	⁴ 42,920	⁴ 6,360,671	4,641	1,086,967	10,461	1,100,988	1,091	224,841
1927.....	46,716	1,690,523	⁴ 45,695	⁴ 6,035,382	3,922	869,425	4,451	296,489	1,357	259,209
1928.....	4,518	205,978	⁴ 25,289	⁴ 3,013,679	4,325	906,515	3,148	240,613	1,008	199,081

¹ Figures not available prior to 1922.

² Not separately enumerated by Bureau of Foreign and Domestic Commerce in 1922 and 1923 but included with "Zinc dross"; Canadian smelters reported imports of 2,804 tons of zinc ore and concentrates from the United States in 1923; exporters from the Joplin district reported 368 tons of concentrates shipped to Belgian smelters in 1924.

³ Exports of zinc ore and dross are lumped together; these figures include the quantity and value of zinc ore exported as shown in the first column.

⁴ Exports of slab zinc made from foreign ore are not given separately but have been included with domestic exports after 1923.

Foreign zinc exported from the United States, 1919-1928

Year	Exported from warehouse			Exported in manufactures with benefit of drawback, slabs and sheets excluded (short tons)
	Blocks, pigs, and old		All other manufactures (value)	
	Short tons	Value		
1919.....	12,256	\$1,943,507	\$13,071	4,533
1920.....	28,132	4,331,636		237
1921.....	1,256	100,677	10,785	130
1922.....	3,471	429,122	30,227	1,298
1923.....	7,080	941,257	(1)	
1924-1928.....	(2)	(2)	(2)	

¹ Not given separately.

² Exports of slab zinc made from foreign ore are not given separately but have been included with domestic exports after 1923.

Domestic zinc ore and domestic and foreign manufactures of zinc exported from the United States, 1927-28, by destinations

Destination	Ore and concentrates		Slabs, blocks, or pigs		Sheets, strips, etc.	
	Short tons	Value	Short tons	Value	Short tons	Value
1927						
North America:						
Canada.....	118	\$6,383	634	\$86,217	1,616	\$298,035
Cuba.....			6	1,589	47	14,891
Mexico.....			394	89,128	68	21,330
Panama.....			6	991	36	6,012
Other.....			1	213	29	7,497
	118	6,383	1,041	178,138	1,796	347,765
South America:						
Argentina.....			4,173	542,929	132	30,239
Brazil.....			52	7,392	45	15,931
Chile.....			906	144,849	26	9,659
Colombia.....			1	298	71	15,585
Peru.....			1	98	16	5,160
Other.....			(1)	135	56	11,840
			5,133	695,701	346	88,414
Europe:						
Belgium.....	28,525	937,190	813	124,563		
France.....	14,128	497,805	3,190	394,656		
Germany.....	1,215	87,300	1,939	253,747	110	23,090
Italy.....			2,257	308,345		
Netherlands.....	1,207	53,930	555	68,570	10	1,590
Soviet Russia.....			890	118,399		
Sweden.....			449	65,410	50	15,945
United Kingdom.....			20,518	2,658,903	1,230	291,478
Other.....			118	15,848	75	21,362
	45,075	1,576,225	30,729	4,008,441	1,475	353,465
Asia:						
China.....			2	361	24	8,367
India (British).....			56	7,395	9	3,333
Japan.....	1,523	107,915	3,724	1,142,439	130	30,987
Philippine Islands.....			7	1,638	78	16,587
Other.....					11	3,806
	1,523	107,915	8,789	1,151,833	252	63,050
Africa.....					4	1,263
Oceania, including Australia.....			3	1,269	49	15,438
	46,716	1,690,523	45,695	6,035,382	3,922	869,425
1928						
North America:						
Canada.....			770	99,364	1,877	334,962
Cuba.....			20	4,260	63	18,577
Mexico.....			86	19,339	53	18,036
Panama.....			13	1,725	15	2,410
Other.....			9	1,816	36	8,415
			898	126,504	2,044	382,400
South America:						
Argentina.....			30	3,959	212	47,858
Brazil.....			71	11,839	68	16,213
Chile.....			590	66,509	22	7,550
Colombia.....			1	296	56	12,829
Peru.....			5	811	14	4,743
Other.....			16	3,103	19	5,915
			713	86,517	391	95,108
Europe:						
Belgium.....	532	23,350	296	35,310		
France.....	1,892	82,000	4,187	487,773	7	1,232
Germany.....	1,664	75,600	4,330	523,416	6	1,228
Italy.....			1,663	201,390	1	186
Netherlands.....			742	95,836	32	5,207
Sweden.....			913	112,927	47	15,262

¹ Less than 1 ton.

Domestic zinc ore and domestic and foreign manufactures of zinc exported from the United States, 1927-28, by destinations—Continued

Destination	Ore and concentrates		Slabs, blocks, or pigs		Sheets, strips, etc.	
	Short tons	Value	Short tons	Value	Short tons	Value
1928—Continued.						
Europe—Continued.						
United Kingdom.....	13	\$480	1, 152	\$132, 365	1, 385	\$313, 762
Other.....	287	20, 648	243	29, 731	41	10, 523
	4, 388	202, 078	13, 526	1, 618, 748	1, 519	347, 400
Asia:						
China.....			46	7, 173	37	12, 482
India (British).....					5	1, 669
Japan.....	130	3, 900	10, 067	1, 167, 779	219	35, 464
Philippine Islands.....			4	787	49	11, 950
Other.....			(1)	92	21	7, 464
	130	3, 900	10, 117	1, 175, 831	331	69, 029
Africa.....			33	5, 620	2	445
Oceania, including Australia.....			2	459	38	12, 133
	4, 518	205, 978	25, 289	3, 013, 679	4, 325	906, 515

¹ Less than 1 ton.

Domestic brass ¹ and brass manufactures exported from the United States, 1919-1928

[Zinc content approximately 30 per cent by weight]

Year	Bars, plates, and sheets		Scrap and old ²		Articles made from brass (value)	Total value
	Short tons	Value	Short tons	Value		
1919.....	3, 885	\$2, 310, 561	661	\$176, 028	\$11, 426, 289	\$13, 912, 878
1920.....	2, 905	1, 671, 608	1, 030	254, 189	13, 202, 854	15, 128, 651
1921.....	1, 437	741, 110	2, 909	405, 871	7, 123, 366	8, 270, 347
1922.....	1, 830	635, 449	3, 147	514, 322	7, 675, 979	8, 825, 750
1923.....	1, 733	703, 503	6, 587	1, 198, 500	6, 917, 901	8, 819, 964
1924.....	2, 265	740, 993	29, 294	5, 352, 197	6, 299, 046	12, 392, 236
1925.....	3, 988	1, 359, 594	48, 189	9, 889, 153	7, 315, 707	18, 564, 454
1926.....	2, 377	884, 907	25, 132	4, 944, 277	7, 844, 746	13, 673, 930
1927.....	1, 756	648, 853	45, 997	8, 824, 029	8, 043, 131	17, 516, 013
1928.....	2, 202	905, 430	42, 413	7, 947, 218	8, 765, 231	17, 617, 879

¹ Beginning 1922, classification reads "Brass and bronze."

² Beginning 1925, classification reads "Ingots, scrap, and old."

CONSUMPTION

APPARENT CONSUMPTION OF PRIMARY SLAB ZINC

Primary zinc consumed in the United States, 1919-1928, in short tons

	1919	1920	1921	1922	1923
Supply:					
Stock Jan. 1—					
In bonded warehouse.....				131	80
At smelters.....	41, 241	36, 793	71, 037	70, 321	16, 810
Production.....	465, 743	463, 377	200, 500	354, 277	510, 434
Imports, foreign.....	70	15	6, 739	52	21
Imports, domestic, returned.....		8, 162	731		
Total available.....	507, 054	508, 347	279, 007	424, 781	527, 345
Withdrawn:					
Exports, foreign, from warehouse.....	12, 256	28, 132	1, 256	3, 471	7, 080
Exports, foreign, under drawback.....	4, 533	237	130	1, 298	
Exports, domestic.....	129, 508	85, 898	3, 569	30, 032	45, 803
Stock Dec. 31—					
In bonded warehouse.....			131	80	80
At smelters.....	36, 793	71, 037	70, 321	16, 810	27, 808
Total withdrawn.....	183, 090	185, 304	75, 407	51, 691	80, 831
Apparent consumption.....	323, 964	323, 043	203, 600	373, 090	446, 514

Primary zinc consumed in the United States, 1919-1928, in short tons—Continued

	1924	1925	1926	1927	1928
Supply:					
Stock Jan. 1—					
In bonded warehouse.....	80	(1)			
At smelters.....	27, 808	20, 754	13, 080	26, 937	53, 522
Production.....	517, 339	572, 946	618, 422	592, 516	602, 581
Imports, foreign.....	25	24	22	59	3
Total available.....	545, 252	593, 724	631, 524	619, 512	656, 106
Withdrawn:					
Exports, foreign, from warehouse.....	(2)	(2)	(2)	(2)	(2)
Exports, foreign, under drawback.....					
Exports, domestic.....	¹ 76, 241	² 80, 547	² 47, 561	² 49, 617	² 29, 614
Stock Dec. 31—					
In bonded warehouse.....	(1)				
At smelters.....	20, 754	13, 080	26, 937	53, 522	48, 432
Total withdrawn.....	96, 995	93, 627	74, 498	103, 139	78, 046
Apparent consumption.....	448, 257	500, 097	557, 026	516, 373	578, 060

¹ 998 pounds.² Foreign exports included under domestic exports.

The foregoing table includes only primary slab zinc, or zinc produced from ores. In addition, a substantial tonnage of redistilled secondary zinc is produced at primary smelters each year, most of which is inseparable from primary metal. For this reason smelter stocks at the end of the year and exports of domestic zinc probably contain some secondary metal. Although the amount is relatively small, the slight inconsistency in the table should be noted. A more precise segregation of figures for primary and secondary metal is practically impossible.

The apparent consumption of zinc in 1928 was a record for all time, and exceeded that of 1927 by 12 per cent and that of 1926, the previous peak, by 4 per cent. Consumption of iron increased 4 per cent, and of primary copper 13 per cent, but that of primary lead decreased 1 per cent. Some of the basic factors contributing to the increased use of zinc were increases of 28 per cent in the number of automobiles and trucks produced and 27 per cent in industrial building contracts awarded.

CONSUMPTION BY USES

Zinc ore may be used for the manufacture of slab zinc, zinc dust, pigments, and salts. This chapter is chiefly concerned with slab zinc, and the discussion that follows is confined to the uses of that product.

Besides the primary zinc consumed, as shown in the preceding table, a large quantity of secondary zinc was recovered in the form of slab zinc, brass and other alloys, pigments, salts, and zinc dust. These items have been discussed briefly in a previous section (p. 373) of this chapter and in more detail in the Mineral Resources chapter on secondary metals. The secondary zinc recovered in 1928 in the form of slab zinc, brass, and other alloys amounted to 149,200 tons. Owing to lack of data regarding stocks it is impossible to state how much of this metal was actually consumed in 1928. It should be noted, however, that the quantity of secondary zinc recovered as slab zinc and in alloys during the last five years has averaged 27 per cent of the apparent consumption of primary zinc.

The three chief uses of slab zinc are in the manufacture of zinc-coated (galvanized) products, in brass making, and in the manufacture of sheet zinc. Other minor uses are in the manufacture of French oxide, atomized zinc dust, die castings, and slush castings, and for desilverization of lead. The following table, which shows the estimated industrial use of zinc in the United States from 1920 to 1928, has been taken from the Year Book of the American Bureau of Metal Statistics, 1928.

*Estimated industrial use of zinc in the United States, 1920-1928, in short tons*¹

Purpose	1920	1921	1922	1923	1924	1925	1926	1927	1928
Galvanizing:									
Sheets.....	99,800	72,500	110,800	121,300	122,900	138,000	142,500	138,500	144,100
Tubes.....	34,000	28,200	44,100	49,000	50,300	61,100	62,100	54,000	51,200
Wire.....	35,900	19,500	25,000	32,700	29,000	35,700	34,200	38,500	41,300
Wire cloth.....	4,800	3,800	6,100	6,100	7,100	6,800	6,800	6,500	8,400
Shapes ²	17,500	14,100	19,400	26,100	30,700	41,400	44,400	42,500	43,000
	192,000	138,100	205,400	235,200	240,000	283,000	290,000	280,000	291,000
Brass making.....	144,000	75,000	145,000	175,000	155,000	165,000	180,000	160,000	180,000
Rolled zinc.....	53,200	30,400	53,500	55,800	61,000	71,100	86,300	74,100	73,500
Die castings.....	(³)	(³)	(³)	(³)	(³)	(³)	13,500	18,000	24,000
Other purposes ⁴	35,000	19,000	36,000	49,000	56,000	60,000	52,500	51,000	58,000
	424,200	262,500	439,900	515,000	512,000	579,100	622,300	583,100	626,500

¹ Year Book, American Bureau of Metal Statistics, 1928, p. 75.

² Includes pole-line hardware, hollow ware, chains, and all articles not elsewhere mentioned. The estimates for the use of slab zinc under this head, and also for wire cloth, are probably incomplete. The enumeration for 1924 includes figures from consumers not previously accounted for.

³ Included in "Other purposes."

⁴ Includes slab zinc used for manufacture of French oxide, lithopone, atomized zinc dust, die castings (through 1925), slush castings, and for the desilverization of lead.

The foregoing table is based upon reports from consumers and apparently includes both primary and secondary slab zinc. The Bureau of Mines estimate of apparent consumption of primary zinc is based upon reports from producers; if the estimated production of secondary metal is added to this, it will be found that the total exceeds the estimated industrial use of zinc, as reported by the American Bureau of Metal Statistics, by about 22,000 tons. Since the price of zinc increased rather steadily during 1928 it would be reasonable to assume that this difference could be accounted for by increased consumer's stocks, although data on this point are not available. A comparison of consumption estimates as reported by the Bureau of Mines and the American Bureau of Metal Statistics during the last five years is given below.

Comparison of figures for consumption of zinc, 1924-1928, as computed by Bureau of Mines and by American Bureau of Metal Statistics, in short tons

	1924	1925	1926	1927	1928
Apparent consumption of primary zinc as per Bureau of Mines.....	448,257	500,097	557,026	516,373	578,090
Industrial use of zinc as per American Bureau of Metal Statistics.....	512,000	579,100	622,300	583,100	626,500
Excess as per American Bureau of Metal Statistics.....	63,743	79,003	65,274	66,727	48,440
Recovery of unalloyed secondary zinc as per Bureau of Mines.....	58,886	61,430	64,570	64,800	70,700

The galvanizing industry is the largest user of slab zinc and has accounted for 47 per cent of the total zinc used in the United States during the past five years. In 1928 the consumption of zinc in this industry exceeded all previous records and was 4 per cent greater than in 1927.

Brass making provides the second largest use of slab zinc and has accounted for 29 per cent of the total consumption during the past five years. It is of interest to note that the use of zinc in brass has not kept pace with the general increase in consumption during the last few years. In 1922 about 33 per cent of the total slab zinc consumed was used in brass, whereas in 1928 the percentage had decreased to 29 per cent. In 1928, however, consumption of zinc in brass was 12½ per cent greater than in 1927. There was a substantial increase in the export of fabricated brass articles in 1928.

The use of zinc in the manufacture of rolled products again decreased in 1928. Although the decrease was less than 1 per cent from 1927, the 1928 output was 15 per cent less than in 1926. This phase of zinc consumption has been adversely affected by the decreased use of dry cells in radio-receiving sets.

Another important use of zinc, and one that presents a promising future, is as the essential constituent of die-casting alloys. During the last three years the use of zinc for this purpose has nearly doubled. In 1928 it was estimated that 24,000 tons was so used. Articles now being die cast from zinc-base alloys include loud-speaker cases, radio-instrument dials, many automobile parts, including hub caps and intricate carburetor parts, soda-water dispensers, pencil-sharpener bodies, and smoking stands.

Other miscellaneous uses accounted for 58,000 tons of zinc or 9 per cent of the total in 1928. Approximately 65 per cent of this item is chargeable to the 37,555 tons of slab zinc used in the manufacture of French process zinc oxide, as reported by the Bureau of Mines. Probably several thousand tons of zinc is used annually in the Parkes process for desilverizing lead, but no data as to the exact amount are available. Some zinc was used in the manufacture of atomized zinc dust in 1928.

Possible new uses for zinc are suggested by research upon zinc of exceptional purity produced by the Tainton process. According to a letter from I. H. Cornell, this metal contains 99.99 per cent zinc and has properties that promise to expand the utilization of zinc into new fields. It is about two-thirds as hard as ordinary high-grade zinc and very much more ductile, and it can be drawn into 0.008 wire, rolled into foil, and rolled into strip and ribbon without annealing. Collapsible and drawn tubes have been made successfully. Differences in impurities, although slight, have a tremendous effect on the physical qualities of the metal. It is being used now principally in the brass and die-casting industries.

A new timber preservative, zinc-meta-arsenite, has been developed by the engineering laboratories of the Western Union Telegraph Co. It is claimed that this compound has toxic properties equal to copper arsenite and greater than zinc chloride, that it is quite permanent and inexpensive, and that it is practically noncorrosive to iron. It is applied by the ordinary pressure methods.

There has been some concern as to the possibility of future substitution of stainless steel for galvanized products, but with present prices of stainless steel over 20 cents per pound there is little possi-

bility of immediate competition except, perhaps, for roofing where a very thin sheet of stainless steel might be used effectively. However, there are rumors to the effect that cheaper stainless steels are possibilities for the near future, and the galvanizing industry will no doubt watch developments in this field carefully.

PRICES AND VALUE

The trend of the price of zinc during 1928 may be described as consistently upward, but the average quoted price for the year was 4 per cent under 1927. The decline which started in November, 1925, when the average quoted price for the month was 8.72 cents per pound at St. Louis, continued with few interruptions until February, 1928, when a low average of 5.55 cents was reached. This was the lowest monthly average since June, 1922. By the end of June, 1928, the monthly average had increased to 6.16 cents, but thereafter improvement was slow, the average for December being 6.35 cents. The average for the year was 6.03 cents, as compared with 6.25 cents in 1927. The low quotation for the year was 5.40 cents on February 24, 1928. A feature of the last half of the year was the remarkable stability of quotations. The high for the year was 6.35 cents, which persisted, without fluctuation, throughout December.

The London price of zinc averaged 5.69 cents per pound in January and then followed an irregular downward course to a low average of 5.20 cents in October. The December average was 5.76 cents. The yearly average was 5.50 cents, as compared to 6.19 cents in 1927, a decrease of 11 per cent.

The following table shows monthly fluctuations in price of prime western zinc at St. Louis during 1923 to 1928 and at London during 1928.

Average monthly quoted price of zinc at St. Louis, 1923-1928, and at London, 1928, in cents a pound¹

Month	St. Louis (for immediate delivery)						London, ² 1928
	1923	1924	1925	1926	1927	1928	
January.....	6.96	6.42	7.76	8.45	6.68	5.65	5.69
February.....	7.25	6.76	7.51	7.84	6.69	5.55	5.55
March.....	7.87	6.49	7.34	7.34	6.71	5.63	5.46
April.....	7.32	6.13	7.00	7.01	6.35	5.76	5.55
May.....	6.72	5.78	6.96	6.82	6.08	6.04	5.69
June.....	6.05	5.79	7.00	7.12	6.23	6.16	5.59
July.....	6.09	5.90	7.22	7.42	6.24	6.20	5.41
August.....	6.35	6.18	7.59	7.39	6.36	6.25	5.31
September.....	6.46	6.19	7.77	7.42	6.22	6.25	5.30
October.....	6.30	6.33	8.33	7.31	6.00	6.25	5.20
November.....	6.36	6.80	8.72	7.22	5.75	6.27	5.37
December.....	6.25	7.38	8.71	7.04	5.73	6.35	5.76
High.....	7.87	7.38	8.72	8.45	6.71	6.35	5.76
Low.....	6.05	5.78	6.96	6.82	5.73	5.55	5.20
Average.....	6.66	6.35	7.66	7.37	6.25	6.03	5.50

¹ Metal Statistics, 1929, pp. 445 and 451.

² Conversion of English quotations into American money based on average monthly rate of exchange, as recorded by the Federal Reserve Board of the Treasury.

New York quoted prices are slightly above St. Louis prices, owing to the freight rate of 0.35 cent per pound between the two places.

According to reports submitted to the Bureau of Mines, the stocks of slab zinc at smelters decreased from 53,522 tons on January 1 to 48,432 tons on December 31, 1928.

The quotation on 60 per cent zinc concentrates at Joplin, Mo., during the first week of January was \$36, \$1 over the closing week of 1927. Early in February it was up to \$38, but quickly reacted to the falling price of zinc, reaching a low of \$35 during the two weeks ended February 25. After this the price increased to \$40 during the week ended May 19, where it remained throughout the rest of the year, notwithstanding an increase in the price of zinc from 6.06 to 6.35 cents. The average price realized on all shipments during the year, as reported by the American Metal Market, was \$38.66, compared with \$41.02 in 1927. The following table shows the average weekly price fluctuations of zinc concentrates at Joplin and of prime western and brass special zinc at St. Louis:

Average weekly quoted prices of 60 per cent zinc concentrates at Joplin, Mo., and of zinc of "prime western" and "brass special" grades at St. Louis, in 1928

Week ended—	60 per cent zinc concentrates in the Joplin region (dollars per ton) ¹	Prime western zinc in St. Louis (cents per pound) ²	Brass special zinc in St. Louis (cents per pound) ²	Week ended—	60 per cent zinc concentrates in the Joplin region (dollars per ton) ¹	Prime western zinc in St. Louis (cents per pound) ²	Brass special zinc in St. Louis (cents per pound) ²
Jan. 7.....	36	5.65	5.70	July 7.....	40	6.20	6.27½
Jan. 14.....	36	5.65	5.70½	July 14.....	40	6.20	6.28½
Jan. 21.....	36	5.62	5.67½	July 21.....	40	6.20	6.30
Jan. 28.....	37	5.66½	5.71½	July 28.....	40	6.20	6.30
Feb. 4.....	38	5.65¾	5.71	Aug. 4.....	40	6.22	6.34½
Feb. 11.....	36	5.63½	5.68¾	Aug. 11.....	40	6.25	6.40
Feb. 18.....	35	5.56¾	5.61¾	Aug. 18.....	40	6.25	6.40
Feb. 25.....	35	5.44¼	5.49¾	Aug. 25.....	40	6.25	6.40
Mar. 3.....	38	5.45¾	5.50¾	Sept. 1.....	40	6.25	6.40
Mar. 10.....	38	5.55¾	5.60¾	Sept. 8.....	40	6.25	6.36¼
Mar. 17.....	40	5.66½	5.71½	Sept. 15.....	40	6.24¾	6.35
Mar. 24.....	38	5.69	5.74	Sept. 22.....	40	6.25	6.35
Mar. 31.....	38	5.69½	5.74½	Sept. 29.....	40	6.25	6.35
Apr. 7.....	38	5.74¼	5.79¼	Oct. 6.....	40	6.25	6.35
Apr. 14.....	38	5.73¾	5.78¾	Oct. 13.....	40	6.25	6.35
Apr. 21.....	38	5.75¼	5.80¼	Oct. 20.....	40	6.25	6.35
Apr. 28.....	38	5.80¼	5.85¼	Oct. 27.....	40	6.25	6.35
May 5.....	39	5.86¼	5.91¼	Nov. 3.....	40	6.25	6.35
May 12.....	39	5.98¼	6.03¼	Nov. 10.....	40	6.25	6.35
May 19.....	40	6.07¼	6.12¼	Nov. 17.....	40	6.25	6.35
May 26.....	40	6.13¼	6.18¼	Nov. 24.....	40	6.25	6.35
June 2.....	40	6.13¾	6.18¾	Dec. 1.....	40	6.34¼	6.45
June 9.....	40	6.14	6.19	Dec. 8.....	40	6.35	6.45
June 16.....	40	6.15	6.20	Dec. 15.....	40	6.35	6.45
June 23.....	40	6.14¾	6.21	Dec. 22.....	40	6.35	6.45
June 30.....	40	6.19	6.26	Dec. 29.....	40	6.35	6.45

¹ Joplin Globe, Joplin, Mo.

² American Metal Market, monthly review section.

The following table shows the actual prices received by producers for various grades of zinc, based upon the producer's classification of products, and the total value reported received:

Average price of zinc, 1919–1928, by grades, in cents per pound

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Grade A (high grade).....	8.3	8.4	5.6	6.0	7.1	6.8	7.85	7.65	6.67	6.18
Grade B (intermediate).....	7.7	8.3	5.5	6.0	7.1	6.8		7.35	6.24	5.99
Grade C (select and brass special).....	7.2	8.2	4.9	5.6	6.7	6.4	7.41	7.46	6.31	6.08
Grade D (prime western).....	7.1	8.0	4.9	5.6	6.7	6.4	7.59	7.5	6.4	6.1
All grades.....	7.3	8.1	5.0	5.7	6.8	6.5	7.6	7.4	6.3	6.0
Prime western; average spot quotation at St. Louis.....	7.0	7.8	4.7	5.7	6.7	6.4	7.7	7.4	6.3	6.0

The American Metal Market reported the following average quoted prices (cents per pound) for 1927 and 1928:

	1927	1928
High-grade zinc (delivered at eastern points)	8. 23	7. 74
Brass special (f. o. b. East St. Louis)	6. 31	6. 11
Prime western (f. o. b. St. Louis)	6. 25	6. 03
Prime western (f. o. b. New York)	6. 60	6. 38

BAUXITE AND ALUMINUM^{1 2}

BAUXITE

DOMESTIC PRODUCTION

In 1928 the bauxite output of the United States was 375,426 long tons, valued at \$2,273,898, an increase of 17 per cent in quantity and of 14 per cent in value, as compared with 1927. Imports of bauxite aggregated 350,111 long tons, valued at \$1,534,498, a decrease of 2 per cent in quantity, as compared with 1927.

Bauxite produced in the United States, 1924-1928

Year	Georgia, Alabama, and Tennessee ¹		Arkansas		Total	
	Long tons	Value ²	Long tons	Value ²	Long tons	Value ²
1924.....	19,940	\$156,990	327,630	\$1,981,000	347,570	\$2,137,990
1925.....	20,220	109,800	296,320	1,878,450	316,540	1,988,250
1926.....	20,680	116,650	371,570	2,298,550	392,250	2,415,200
1927.....	17,110	95,920	303,830	1,892,860	320,940	1,988,780
1928.....	14,190	80,668	361,236	2,193,230	375,426	2,273,898

¹ No production from Alabama in 1924, 1925, and 1926, and none from Tennessee in 1927.

² Value f. o. b. mines.

Domestic bauxite was reported as sold to four consuming industries in 1928, as shown in the table that follows. Sales of domestic bauxite to the aluminum industry increased 17 per cent, those to manufacturers of aluminum salts 35 per cent, and those to makers of artificial abrasives 2 per cent, as compared with 1927.

Domestic bauxite sold by producers to industries in the United States, 1924-1928, in long tons

Industry	1924	1925	1926	1927	1928
Aluminum.....	225,780	173,040	241,850	186,490	218,398
Chemical.....	54,870	67,420	77,960	62,410	83,992
Abrasive ^a	66,400	73,720	72,210	71,790	72,931
Refractory.....	440	260	230	160	105
Alumina cement.....	80	-----	-----	90	-----

^a Includes alumina used for refractories.

¹ Work on manuscript completed February, 1930.

² Statistics relating to domestic production for 1928 were prepared by H. W. Davis, for preceding years by Helen M. Gaylord, both of the Bureau of Mines; figures on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the Bureau of Mines.

For a number of years it has been impossible to give separate statistics showing the output of either artificial aluminous abrasives or refractories. Some measure of the combined output of these materials made from bauxite may be had from the quantity of bauxite sold to manufacturers, as indicated in the preceding table. Figures for aluminous abrasives heretofore reported in the chapters on bauxite and aluminum and abrasives in Mineral Resources have included annually increasing quantities of aluminum oxide used as refractory material.

Value of aluminum and aluminum salts made from bauxite, 1924-1928

Year	New aluminum	Aluminum salts
1924.....	\$37,607,000	\$9,301,400
1925.....	36,430,000	13,155,790
1926.....	37,583,000	13,202,010
1927.....	39,266,000	14,288,430
1928.....	47,899,000	13,990,264

IMPORTS AND EXPORTS

Bauxite imported into and bauxite and bauxite concentrates exported from the United States, 1924-1928

Year	Imports for consumption		Exports (including bauxite concentrates)	
	Long tons	Value	Long tons	Value
1924.....	201,974	\$909,493	77,065	\$3,979,832
1925.....	353,696	1,549,120	78,633	4,134,455
1926.....	281,644	1,187,497	87,770	4,741,260
1927.....	356,580	1,572,236	121,858	7,800,491
1928.....	350,111	1,534,498	112,984	5,210,912

WORLD PRODUCTION

World production of bauxite, 1924-1928, by countries, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country	1924	1925	1926	1927	1928
Australia: Victoria.....				936	196
British Guiana ¹	156,800	177,808	189,101	163,454	168,077
Bulgaria.....	796				
France.....	388,692	502,189	508,129	540,000	597,810
Germany.....	3,085	1,767			6,860
Greece.....	1,300	3,700	2,320	4,300	300
Hungary.....	192	390	3,667	339,464	395,974
India, British.....	23,601	10,232	5,036	4,379	14,902
Ireland, Northern.....	5,241	5,121	(2)	5,394	2,322
Italy.....	140,790	195,000	90,500	95,300	162,229
Rumania.....			745	1,706	653
Spain.....					181
Surinam (Dutch Guiana).....	63,097	86,277	44,230	184,203	213,869
United States.....	353,148	321,620	398,546	326,091	381,452
Yugoslavia.....	18,485	79,032	131,828	100,327	49,264
	1,155,000	1,383,000	1,379,000	1,766,000	1,994,000

¹ Exports.

² Estimate included in total.

ALUMINUM

DOMESTIC PRODUCTION—IMPORTS AND EXPORTS

The value of the new aluminum produced in the United States in 1928, \$47,899,000, was 22 per cent greater than that in 1927, and the value of the secondary aluminum, \$22,848,400, was 3 per cent less than in 1927.

According to statistics collected by J. P. Dunlop, of the Bureau of Mines, secondary aluminum was recovered to the amount of 24,500 short tons as metal and 23,300 short tons as the aluminum content of casting alloys. The total recovery was 47,800 short tons.

Value of aluminum produced in, imported into, and exported from the United States, 1919-1928

Year	Domestic production		Imports ²	Exports ¹
	Primary metal	Secondary metal ¹		
1919	\$38,558,000	\$12,014,600	\$4,568,595	\$3,890,326
1920	41,375,000	9,489,100	13,077,022	5,630,781
1921	10,906,000	3,775,400	8,889,791	3,108,857
1922	13,622,000	6,085,900	9,695,012	2,836,116
1923	28,305,000	10,824,600	8,742,563	3,571,539
1924	37,607,000	14,596,200	7,145,036	4,172,390
1925	36,430,000	24,816,000	10,106,767	6,057,071
1926	37,583,000	23,868,000	16,779,377	4,452,303
1927	39,266,000	23,469,600	14,201,978	6,307,421
1928	47,899,000	22,848,400	8,873,475	6,891,490

¹ Value of secondary aluminum based on average price at New York as given by American Metal Market.

² Imports for consumption include aluminum in crude form, scrap, bars, strips, rods, plates, sheets, and all manufactures of aluminum.

³ Exports include ingots, metal and alloy, plates and sheets, and all manufactures of aluminum.

Aluminum imported for consumption in the United States, 1927 and 1928, by classes

Class	1927		1928	
	Pounds	Value	Pounds	Value
Crude and semicrude:				
Crude form, scrap, alloy, etc.	62,246,665	\$13,237,803	38,822,504	\$8,046,831
Plates, sheets, bars, strips, rods, coils, and blanks.	328,557	79,183	23,924	10,083
Circles, disks, rectangles, and squares.			579	193
	62,575,222	13,316,986	38,847,007	8,057,107
Manufactures:				
Leaf (5½ by 5¼ inches)	(1)	28,648	(1)	36,754
Powder, powdered foil.	116,101	45,927	306,906	115,920
Foil less than 0.006 inch thick.	1,094,791	627,918	848,317	474,066
Table, kitchen, and hospital utensils and other similar hollow ware.	137,419	72,163	146,959	75,737
All other manufactures.	(2)	110,336	(2)	113,891
		884,992		816,368
Grand total.		14,201,978		8,873,475

¹ 1927: 18,967,042 leaves; 1928: 26,631,248 leaves; equivalent in pounds not recorded.

² Quantity not recorded.

Exports of ingots, scrap, and alloys in 1928 decreased 32 per cent compared with those in 1927, and exports of tubes, moldings, etc., decreased 34 per cent, but exports of plates, sheets, bars, strips, and

rods increased 21 per cent. The value of table, kitchen, and hospital utensils exported in 1928 increased 14 per cent, and that of other manufactured goods increased 19 per cent.

Domestic aluminum exported from the United States, 1927 and 1928, by classes

Class	1927		1928	
	Pounds	Value	Pounds	Value
Crude and semicrude:				
Ingots, scrap, and alloys.....	3, 525, 085	\$741, 954	2, 390, 498	\$443, 895
Plates, sheets, bars, strips, and rods.....	10, 997, 475	2, 736, 695	13, 337, 783	3, 314, 833
	14, 522, 560	3, 478, 649	15, 728, 281	3, 758, 728
Manufactures:				
Tubes, moldings, castings, and other shapes.....	1, 329, 615	499, 767	1, 003, 957	398, 250
Table, kitchen, and hospital utensils.....	(1)	565, 443	(1)	643, 205
Other manufactures of aluminum.....	(1)	1, 763, 562	(1)	2, 091, 307
	(1)	2, 828, 772	(1)	3, 132, 762
Grand total.....	(1)	6, 307, 421	(1)	6, 891, 490

¹ Quantity not recorded for table, kitchen, and hospital utensils and other manufactures.

ALUMINUM SALTS

Manufacturers of aluminum salts reported a consumption of 141,310 long tons of bauxite in 1928, having an average value of \$13.04 a ton at the plant, as compared with 137,870 tons in 1927, with an average value of \$13.47. Of the bauxite consumed in 1928, 83,067 tons was domestic bauxite, valued at \$970,645, and 58,243 tons was imported bauxite, valued at \$871,579. An unrecorded quantity of high-alumina clay, 5,158 tons of alumina hydrate, and 458 tons of aluminum were also used in the preparation of aluminum salts. These figures do not include the bauxite made into alumina as a preliminary step in the manufacture of aluminum.

Aluminum salts produced in the United States, 1927 and 1928

Salt	1927				1928			
	Number of producers reporting	Short tons	Value		Number of producers reporting	Short tons	Value	
			Total	Average			Total	Average
Alum:								
Ammonia.....	5	5, 200	\$319, 820	\$62	6	5, 018	\$292, 767	\$58
Sodium.....	3	14, 230	928, 870	65	3	15, 718	845, 709	54
Aluminum chloride:								
Liquid.....	4	2, 760	139, 830	51	4	2, 403	126, 236	53
Crystal.....	3	270	36, 130	134	3	372	44, 644	120
Anhydrous.....	3	14, 100	3, 878, 120	275	3	13, 995	3, 708, 094	265
Aluminum sulphate:								
Commercial--								
General.....	14	309, 400	7, 708, 450	25	12	311, 775	7, 538, 084	24
Municipal.....	5	6, 810	149, 540	22	6	8, 444	152, 373	18
Iron-free.....	8	20, 210	706, 910	35	7	23, 940	820, 945	34
Other aluminum salts.....	¹ 6	5, 790	420, 760	-----	¹ 6	5, 240	461, 412	-----
		378, 770	14, 288, 430	-----		386, 905	13, 990, 264	-----

¹ Two producers each of potash alum, alumina, and sodium aluminate.

Aluminum salts produced in, imported into, and exported from the United States, 1924-1928

Year	Domestic production		Imports		Exports (aluminum sulphate) ¹	
	Short tons	Value	Short tons	Value	Short tons	Value
1924-----	302, 190	\$9, 301, 410	2, 523	\$113, 075	16, 012	\$407, 749
1925-----	335, 480	13, 155, 790	3, 205	140, 518	20, 756	505, 537
1926-----	373, 695	13, 202, 010	2, 937	140, 994	22, 031	521, 123
1927-----	378, 770	14, 288, 430	1, 845	83, 288	21, 128	491, 317
1928-----	386, 905	13, 999, 264	1, 425	68, 096	122, 713	1552, 342

¹ Also 418 short tons of "other aluminum compounds," valued at \$85,809, exported in 1928; not separately classified prior to 1928.

ALUMINOUS ABRASIVES AND REFRACTORIES

The use of aluminous abrasives and high-alumina refractories continues to grow. Makers of artificial abrasives took 72,931 long tons of domestic bauxite in 1928. Expansion is shown by the increasing demand for high-alumina clays and other aluminous minerals by ceramists all over the country. In 1928 the makers of refractory brick took 105 long tons of domestic bauxite and 37,439 short tons of high-alumina (diaspore and burley) clay. Alumina by-product in excess of 1,100 tons was shipped from Marysville, Utah, to California and New Jersey makers of refractories.

ALUMINA CEMENTS

No domestic bauxite was reported by producers in the United States as sold to makers of high-alumina cement in 1928; imported bauxite chiefly is used in the manufacture of this product. The use of alumina cements continued to expand during 1928 but is meeting strong competition by the use of the so-called "high early strength" Portland cements.

GOLD, SILVER, AND LEAD IN SOUTH DAKOTA ^{1 2}

(MINE REPORT)

By CHAS. W. HENDERSON

SUMMARY

Metal mining in South Dakota is confined to the three southwestern counties—Custer, Lawrence, and Pennington—in what is known as the Black Hills. The Homestake gold mine, at Lead, Lawrence County, has been producing almost continuously since 1875 and is now the largest producing gold mine in the United States. Ore from this mine to the company's mills amounted to 1,416,949 tons in 1928, an increase of 45,366 tons over 1927, but the revenue from the sale of gold-silver bullion bars amounted to \$6,566,784.69 in 1928—\$113,017.62 less than in 1927. The other producing mines in South Dakota in 1928 were three lode mines in the Keystone district, Custer and Pennington Counties, one lode mine near Hill City, Pennington County, and four small sluice placer mines near Tinton, Lawrence County. The following table shows the number of producing mines, tons of ore produced, and recovered content of metals in South Dakota from 1919 to 1928, inclusive.

Mine production of gold, silver, and lead in South Dakota, 1919-1928, in terms of recovered metals ^a

Year	Mines producing			Ore (short tons)	Gold (lode and placer)		Silver (lode and placer)		Lead		Total value
	Lode	Placer	Total		Fine ounces	Value	Fine ounces	Value	Pounds	Value	
1919...	9	3	12	1,330,368	235,249.57	\$4,863,040	116,493	\$130,472	32,547	\$1,725	\$4,995,237
1920...	3	4	7	1,356,189	226,224.23	4,676,470	90,795	98,966	12,812	1,025	4,776,461
1921...	3	6	9	1,725,685	319,524.95	6,605,167	112,464	112,464	4,000	180	6,717,811
1922...	3	3	6	1,751,454	315,297.99	6,517,788	118,760	118,760	-----	-----	6,636,548
1923...	5	-----	5	1,665,439	309,905.05	6,406,306	95,844	78,592	-----	-----	6,484,898
1924...	4	-----	4	1,674,720	295,930.21	6,117,421	80,548	57,987	-----	-----	6,175,408
1925...	3	-----	3	1,590,079	289,747.10	5,989,604	96,133	66,716	-----	-----	6,056,320
1926...	2	2	4	1,415,785	279,528.93	5,778,376	82,186	51,284	-----	-----	5,829,660
1927...	2	2	4	1,376,583	322,031.74	6,656,987	96,171	54,529	138,000	8,694	6,720,210
1928...	5	4	9	1,422,233	317,378.94	6,560,805	90,547	52,970	74,000	4,292	6,618,067

^a For total production of gold and silver in South Dakota, by years, see Mineral Resources, 1913, pt. 1 p. 42, and Mineral Resources, 1922, pt. 1, p. 194.

Work on manuscript completed January, 1930.

² For information on the geology of the metal resources of South Dakota see Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Central Black Hills Folio 219. 1925.

Gold and silver produced at placer mines in South Dakota, 1919-1928

Year	Gold		Silver		Total value
	Fine ounces	Value	Fine ounces	Value	
1919.....	19. 16	\$396	1	\$1	\$397
1920.....	27. 91	577	5	5	582
1921.....	89. 44	1, 849	7	7	1, 856
1922.....	87. 99	1, 819	7	7	1, 826
1923-1925.....					
1926.....	6. 43	133			133
1927.....	14. 46	299			299
1928.....	11. 13	230			230

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1. 12	\$0. 186	\$0. 053	\$0. 073	1924.....	\$0. 670	\$0. 131	\$0. 080	\$0. 065
1920.....	1. 09	. 184	. 080	. 081	1925.....	. 694	. 142	. 087	. 076
1921.....	1. 00	. 129	. 045	. 050	1926.....	. 624	. 140	. 080	. 075
1922.....	1. 00	. 135	. 055	. 057	1927.....	. 567	. 131	. 063	. 064
1923.....	. 82	. 147	. 070	. 068	1928.....	. 585	. 144	. 058	. 061

MINING AND METALLURGIC INDUSTRY

Production at the Homestake mine was continuous during 1928. A review of the Homestake and other operations is noted under the review by counties.

Gold and silver bullion produced at mills in South Dakota by amalgamation, 1919-1928

Year	Ore treated	Gold in bullion	Silver in bullion	Quicksilver used
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>
1919.....	1, 192, 588	146, 815. 80	41, 595	9, 000
1920.....	1, 274, 944	148, 018. 30	42, 863	8, 660
1921.....	1, 620, 588	214, 003. 69	60, 604	22, 500
1922.....	1, 663, 525	218, 247. 50	58, 806	7, 500
1923.....	1, 652, 337	216, 907. 61	60, 624	10, 725
1924.....	1, 674, 720	203, 174. 24	52, 920	7, 625
1925.....	1, 589, 711	195, 865. 49	49, 812	7, 500
1926.....	1, 415, 785	187, 119. 66	47, 284	5, 625
1927.....	1, 371, 583	208, 952. 00	52, 480	14, 188
1928.....	1, 417, 029	211, 921. 22	51, 649	10, 550

Gold and silver bullion produced at mills in South Dakota by cyanidation, 1919-1928

Year	Material treated			Gold in bullion	Silver in bullion	Sodium cyanide used
	Crude ore	Sands and slimes	Total			
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>
1919.....	136,893	1,157,945	1,294,838	86,017.98	72,662	284,653
1920.....	81,135	1,245,419	1,326,554	78,062.93	44,456	339,122
1921.....	49,047	1,620,588	1,669,635	105,360.12	50,811	395,228
1922.....	87,929	1,620,699	1,708,628	96,962.50	59,947	387,683
1923.....	13,087	1,626,234	1,639,321	92,960.74	35,135	361,900
1924.....	-----	1,647,344	1,647,344	92,756.00	33,628	361,650
1925.....	-----	1,567,555	1,567,555	92,528.61	32,005	347,242
1926.....	-----	1,402,472	1,402,472	92,402.84	34,902	299,672
1927.....	-----	1,353,298	1,353,298	113,058.32	41,005	312,626
1928.....	5,109	1,371,096	1,376,205	105,444.56	37,421	1335,675

¹ Actually 671,350 pounds of cyanamid; reduced to equivalent of 96 to 98 per cent strength to conform with earlier use of figures for high strength NaCN and KCN.

Mine production of metals from South Dakota crude ore shipped to smelters, 1919-1928, in terms of recovered metals

Year	Crude ore	Gold	Silver	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>
1919.....	247	2,386.11	1,615	3,792
1920.....	110	115.09	3,471	12,812
1921.....	157	71.70	1,042	4,000
1922.....	-----	-----	-----	-----
1923.....	15	36.70	85	-----
1924.....	-----	-----	-----	-----
1925.....	368	1,353.00	14,316	-----
1926-27.....	-----	-----	-----	-----
1928.....	95	2.03	1,477	74,000

REVIEW BY COUNTIES

CUSTER COUNTY

Mine production of gold, silver, and lead in Custer County, S. Dak., 1919-1928, in terms of recovered metals

Year	Mines producing		Ore	Gold (lode and placer)	Silver (lode and placer)	Lead	Total value
	Lode	Placer					
			<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	
1919.....	1	-----	440	\$27	483	25,962	\$1,944
1920.....	-----	-----	-----	-----	-----	-----	-----
1921.....	-----	3	-----	582	1	-----	583
1922-1925.....	-----	-----	-----	-----	-----	-----	-----
1926.....	-----	1	-----	30	-----	-----	30
1927.....	1	-----	5,000	144	2,686	138,000	10,361
1928.....	1	-----	95	42	1,477	74,000	5,198

The destruction by fire on January 3, 1928, of the power plant at the Cuyahoga property, 17 miles from Custer and 6 miles from Keystone, resulted in the closing of the mine and mill. Operations were not resumed in 1928, but a clean-up of lead-[zinc]-gold-silver concentrates was shipped to Omaha. A nearly vertical shaft, 325 feet deep, with levels at 100, 200, and 300 feet, opens the property. The mill is

a 100-ton plant equipped with 1 crusher, 1 set of rolls, 1 Marcy ball mill, 1 Dorr drag classifier, 1 Wilfley pilot table, 1 eight-cell "Mineral Separation" flotation machine for lead, 1 ten-cell "Mineral Separation" flotation machine for zinc (not used), 2 Dorr thickeners, and 1 United disk filter.

LAWRENCE COUNTY

Mine production of gold, silver, and lead in Lawrence County, S. Dak., 1919-1928, in terms of recovered metals

Year	Mines producing	Ore	Gold (lode and placer)	Silver (lode and placer)	Lead	Total value
		<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	
1919	11	1,329,928	\$4,863,013	116,010	6,585	\$4,993,293
1920	7	1,356,189	4,676,470	90,795	12,812	4,776,461
1921	3	1,725,685	6,603,318	112,457	4,600	6,715,955
1922	4	1,751,414	6,515,969	118,753	-----	6,634,722
1923	4	1,665,437	6,406,206	95,844	-----	6,484,793
1924	1	1,670,300	6,091,100	86,354	-----	6,148,957
1925	2	1,590,069	5,988,570	96,133	-----	6,055,286
1926	2	1,415,775	5,777,545	82,186	-----	5,828,829
1927	2	1,371,583	6,656,738	93,485	-----	6,709,744
1928	1	1,416,949	6,533,894	88,829	-----	6,585,859

HOMESTAKE MINE ³

The total value of the product of the Homestake Mining Co. from 1875 to 1928, inclusive, is \$219,603,290.24, and the amount paid in dividends is \$54,101,284.29.

Ore milled, receipts, and dividends, Homestake mine, 1919-1928

Year	Ore milled	Receipts for bullion product		Dividends
		Total	Per ton	
	<i>Short tons</i>			
1919	1,192,588	\$4,346,115.79	\$3.6443	\$1,130,220
1920	1,274,944	4,410,193.73	3.4591	-----
1921	1,620,588	6,299,780.38	3.8873	502,320
1922	1,663,485	6,285,317.56	3.7784	879,060
1923	1,652,337	6,400,078.42	3.8733	1,506,960
1924	1,670,300	6,126,349.99	3.6678	1,758,120
1925	1,589,701	5,999,073.50	3.7737	1,758,120
1926	1,415,775	5,811,943.90	4.1051	1,758,120
1927	1,371,583	6,679,802.31	4.8701	1,758,120
1928	1,416,949	6,566,784.69	4.6345	1,758,120

The annual report⁴ of the general manager of the Homestake Mining Co. for the year ended December 31, 1928, says:

I am pleased to report that the mine and mills of the company were operated continuously throughout the year 1928.

The engineers report as follows: Development drifts driven 11,486 feet; development raises driven 7,064 feet.

³ For description of geology see Paige, Sidney, The Geology of the Homestake Mine: Econ. Geology, vol. 18, 1923, pp. 205-237; Geology of the Region Around Lead, S. Dak., and Its Bearing on the Homestake Ore Body: U. S. Geol. Survey Bull. 765, 1924, 56 pp.; Central Black Hills, S. Dak.: U. S. Geol. Survey Geol. Atlas, Folio 219, 1925. Hosted, J. O., and Wright, L. B., Geology of the Homestake Ore Bodies and the Lead Area, South Dakota: Eng. and Min. Jour.-Press, vol. 115, May 5, 1923, pp. 793-799; May 12, 1923, pp. 836-843.

⁴ See also Engineering and Mining Journal, extracts from report: Vol. 127, No. 15, Apr. 13, 1929, p. 617; vol. 127, No. 16, Apr. 20, 1929, p. 659.

The B. & M. No. 2 shaft is completed to a depth of 60 feet below the 1,550-foot level.

There are 616,160 tons of ore broken down and remaining in the stopes.

There are 15,136,755 tons of ore blocked out and remaining in the mine.

The new power plant and tippie at the Wyodak coal mine were put into regular operation about the middle of October.

Complete automatic sprinkler systems, approved by the National Underwriters, have been installed in the Nemo saw mill, pattern shop, and storehouse, and the machine-blacksmith shop and Ellison crusher house are partially protected by automatic sprinklers.

The various milling plants are in good condition and should operate for a number of years with only ordinary repairs.

The mine is in good physical condition for the extraction of ore without undue loss.

Statement of operations of the Homestake mine, Lead, S. Dak., for the year ended December 31, 1928

Operating revenue:

Bullion—

Proceeds of bars 6982-7220..... \$6, 566, 784. 69

During the year 1,416,949 tons of ore were milled, realizing an average of \$4.63445 per ton.

Wolframite ore operation..... 6, 415. 57

Golden Gate timber operation..... 2, 345. 88

Wyodak coal operation..... 22, 698. 14

Interest and rents..... 131, 714. 17

\$6, 729, 958. 45

Operating expenses:

Mining, hoisting, and primary crushing... 2, 247, 779. 15

Tramming..... 71, 027. 29

Milling..... 643, 430. 04

Express on bullion..... 7, 340. 37

Employees' welfare..... 152, 799. 75

Taxes..... 498, 949. 39

Insurance..... 19, 560. 00

Salaries, office, legal and general expenses... 191, 842. 38

3, 832, 728. 37

Income..... 2, 897, 230. 08

Charges against income: Reserved for depreciation and depletion..... 1, 423, 683. 02

Net income..... 1, 473, 547. 06

Dividends for the year:

Paid from net income for year, as above..... 1, 473, 547. 06

Paid from depletion reserve..... 284, 572. 94

Total for year..... 1, 758, 120. 00

The Homestake mine is opened by three main shafts, the deepest of which is 2,400 feet, and by about 66 miles of adits, drifts, and crosscuts. The mining methods used at the Homestake have been described by Ross and Wayland.⁵

The milling plants operated by the Homestake Mining Co. in 1928 consisted of four amalgamation mills and three cyanidation mills. The amalgamation mills were the South mill, at Lead, built in 1922; the Amicus mill, at Lead, originally built in 1879; the Pocahontas mill, at Terraville, built in 1881; the Tungsten mill (treating wolframite ore with some gold), at Lead, built in 1926. The cyanidation mills were the Sand plant No. 1, at Lead, built in

⁵ Ross, A. J. M., and Wayland, R. G., Mining Methods at the Homestake: Min. and Met., vol. 7, No. 229, January, 1926, p. 21.

1901; the Sand plant No. 2, at Blacktail, built in 1902; and the Slime plant, at Deadwood, built in 1906. The sands from the amalgamation mill at Terraville go to Sand plant No. 2, and the sands from the amalgamation mills at Lead go to Sand plant No. 1; the slimes from all four amalgamation mills go to the Slime plant.

The capacity and equipment of these mills are as follows: South mill, 2,032 tons per day, 120 gravity stamps (1,550 pounds each), 2,860 square feet of amalgamating plates, eight 5 by 10 foot rod mills, four 5 by 14 foot tube mills, one 8 by 6 foot tube mill, 10 Dorr drag classifiers, and 13 cone classifiers; Amicus mill, 1,200 tons per day, 240 gravity stamps (1,000 pounds each), 3,780 square feet of amalgamating plates, three 5 by 14 foot tube mills, two 5 by 18 foot tube mills, 5 Dorr drag classifiers, and 12 cone classifiers; Pocahontas mill, 644 tons per day, 160 gravity stamps (900 pounds each), and 2,592 square feet of amalgamating plates; Tungsten mill, 18 tons per day, 1 gyratory crusher, 5 gravity stamps (900 pounds each), 36 square feet of amalgamating plates, 1 special 32 by 42 inch ball mill, 6 concentration tables, and 2 dryers; Sand plant No. 1, 1,730 tons per day, 26 special cone classifiers, 18 special hydraulic classifiers, 19 leaching tanks (each 45 feet in diameter), 11 Dorr thickening tanks, 21 cone bottom thickening tanks, and 2 Merrill precipitation presses; Sand plant No. 2, 361 tons per day, 17 special cone classifiers, 4 leaching tanks (each 54 feet in diameter), 14 cone bottom thickening tanks, and 1 Merrill precipitation press; and Slime plant, 1,660 tons per day, 31 Merrill frame filter presses, and 2 Merrill precipitation presses. A summarization of the foregoing shows that the amalgamation plants in 1928 had a total capacity of 3,894 tons per day and the cyanidation plants, 3,751 tons per day.

The operation of the Tungsten mill was discontinued November, 1928, because of exhaustion of wolframite ore supply.

Four small placers on Potato, Beaver, and Iron Creeks, near Tinton, Lawrence County, yielded 11.44 crude ounces of gold, which after melting weighed 11.13 ounces, and averaged 0.926¼ fineness gold and 0.069½ fineness silver.

PENNINGTON COUNTY

Mine production of gold and silver in Pennington County, S. Dak., 1919-1928, in terms of recovered metals

Year	Mines producing		Ore	Gold (lode and placer)	Silver (lode and placer)	Total value
	Lode	Placer				
			Short tons		Fine ounces	
1919-20.....						
1921.....		3		\$1,267	6	\$1,273
1922.....	1	1	40	1,819	7	1,826
1923.....	1		2	100		100
1924.....	3		4,420	26,321	194	26,451
1925.....	1		10	1,034		1,034
1926.....	1		10	801		801
1927.....		1		105		105
1928.....	3		5,189	26,869	241	27,010

The National Tin Corporation, in December, 1926, began the development of the Gold Mint Lode property, in section 28, T. 1 S. of the Black Hills base line, R. 5 E. of Black Hills meridian, near Hill City, and in 1927 and 1928 sank an incline shaft approximately 250 feet deep, the first 180 feet on the vein and the last 70 feet off the vein. The corporation also sank a 75-foot vertical shaft and drove 40 feet of drifts, built a 10-stamp mill, and erected a shaft and boiler house. In 1928 a test run of 80 tons of free milling gold ore was made, yielding gold-silver bullion averaging 0.657¼ fineness gold and 0.327 fineness silver. Operations ceased October 15, 1928.

In 1928 the Keystone Consolidated Mines Co. (Inc.) continued development and construction work begun August, 1927, at the old Columbia-Holy Terror-Keystone-Bullion-Lucky Boy group, in the Keystone district, across the county line in Pennington County. Development work in 1928 consisted of driving approximately 2,000 feet of drifts and of opening stopes from the 300-foot vertical shaft. A Diesel engine electric power plant and a 120-ton cyanidation plant were completed. The mill was operated at short periods to handle ore separated from rock broken in development work. A car of gold ore was also shipped to the Golden Cycle mill, Colorado Springs. From claims adjoining the Keystone Consolidated group the Consolidated Power & Development Co. in 1928 extracted a small tonnage of gold-silver ore, which was treated in one of the old mills of the district.

GOLD, SILVER, AND COPPER IN WYOMING ¹

(MINE REPORT)

By CHAS. W. HENDERSON

SUMMARY

In 1928 Wyoming metal mines (not including iron mines) produced gold, silver, and copper, valued in terms of recovered metals, at \$1,083, as compared with gold and silver valued at \$1,203 in 1927. No copper was produced in 1927. In 1928, an amalgamating mill in the Atlantic City district, Fremont County, produced gold-silver bullion; a car of copper-silver ore was shipped direct to smelter from the Michigan prospect, in Muskrat Creek, Goshen County; and a prospector in the Wind River Range, Fremont County, pounded out several ounces of gold-silver bullion. The Sunrise iron mine, at Sunrise, continued to supply a large part of the raw iron ore treated at the iron and steel mill at Pueblo, Colo., but it yielded no copper ore in 1928.

Mine production of gold, silver, and copper in Wyoming, 1919-1928, in terms of recovered metals

Year	Ore (short tons)	Gold	Silver		Copper		Total value
			Fine ounces	Value	Pounds	Value	
1919-----	798	\$84	151	\$169	139,900	\$26,021	\$26,274
1920-----							
1921-----	50	62	111	111	10,000	1,290	1,463
1922-----	24	1,207	57	57	4,296	580	1,844
1923-----	584	296	254	208	111,280	16,358	16,862
1924-1926-----							
1927-----	110	1,200	5	3			1,203
1928-----	129	677	53	31	2,604	375	1,083

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

¹ Work on manuscript completed January, 1930.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

REVIEW BY COUNTIES AND DISTRICTS

ALBANY COUNTY

*Centennial district.*²—The Cliff property and 100-ton amalgamation-flotation mill, on the Middle Fork of Little Laramie River, were idle. Development work was done at the Utopia group, near Centennial. The concentration mill, built near Centennial to treat rock from the Queen claim on Centennial Mountain, was not operated.

Douglas Creek district (Holmes, Forpark).—Assessment work was done at the Rambler group, at Holmes, once a producer of gold-silver-copper-platinum-palladium ore.³ The last shipments from this mine were in 1923, when 55 tons of ore from the dump was settled for on a payment basis for contents of 8.56 ounces of gold, 104 ounces of silver, 6,717 pounds of copper, 4.39 ounces of platinum, and 23.99 ounces of palladium. Assessment and small development work was done at the Gold Crater lode claim, Independence lode claim, and Moore's Gulch placer and lode groups.

*Tie Siding district.*⁴—The Copper-Gold Mining & Milling Co. completed a concentration mill in August, 1928, at the Atlas group, near Tie Siding, but produced nothing in 1928.

CARBON COUNTY

Encampment district.—Annual assessment work was done at several prospects in the Encampment district.

CONVERSE COUNTY

The Gloria Mining Association sank one vertical shaft 73 feet and twelve 10-foot holes on its claims near Glenrock.

The Miami Copper Co., in developing the Miami group in section 10, T. 29 N., R. 75 W. of the sixth principal meridian, 25 miles from Douglas, sank the shaft from 238 feet to 280 feet. There are 5 drifts from the shaft, totaling about 500 feet. The property is equipped with a steam plant for power, compressor, hoist, electric generator for lighting, 180-gallon station pump, 50-gallon sinking pump, and air drills.

²For map and description of properties see Hess, F. L., *Platinum Near Centennial, Wyo.*; Contributions to Economic Geology: U. S. Geol. Survey Bull. 780, 1926, pp. 127-135.

³See Kemp, J. F., *Platinum in the Rambler Mine, Wyoming*; Mineral Resources, 1902, pp. 244-250.

⁴For general geology and cross section see Darton, N. H., and Siebenthal, C. E., *Geology and Mineral Resources of the Laramie Basin, Wyoming*; U. S. Geol. Survey Bull. 364, Plates I and VIII, 1909.

FREMONT COUNTY

*Atlantic City district.*⁵—The Carissa mine, which had once been a producer but had been idle and kept unwatered for many years by its owners, was leased October 1, 1928, to the Midwest Mining Co., but no work was done in 1928. The mine is opened by a 384-foot shaft and 2,500 feet of drifts and crosscuts. The Hidden Hand mine and its 10-stamp mill, which produced bullion in 1927, were idle in 1928. The B. & H. Mining Co. built a 10-stamp amalgamation mill on the Ellen Mc group and milled 100 tons of gold ore. Development work was done at the "1914" or Sullivan property. Assessment work was continued on several unpatented claims in the Atlantic City district.

Wind River Range.—A prospector in the Wind River Range, Fremont County, hammered out a few ounces of gold from a surface prospect and abandoned the prospect.

GOSHEN COUNTY

Muskrat Creek district.—A car of silver-copper ore was shipped from the Michigan property to the Anaconda (Mont.) smelter.

LARAMIE COUNTY

Silver Crown district (Hecla).—Assessment and development work was done in 1928 on the Rambler and Monte Christo groups of claims.

PLATTE COUNTY

The Colorado Fuel & Iron Co.'s Sunrise iron mine at Sunrise continued to supply iron ore to the company's iron and steel plant at Pueblo, Colo. No copper ore was shipped from this property in 1928.

⁵ For geology see Spencer, A. C., The Atlantic Gold District and the North Laramie Mountains, Fremont, Converse, and Albany Counties, Wyoming: U. S. Geol. Survey Bull. 626, 1916.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA ¹

(MINE REPORT)

By V. C. HEIKES ²

SUMMARY

In 1928 the total value of the mine production of gold, silver, copper, lead, and zinc in Nevada was \$31,033,776, or 33 per cent more than in 1927, but the number of operations reporting production (359) was 50 less. The quantity and value of each metal except lead increased. The output of lead was only 37,374 pounds less, so that with the increase in the quantity of ore mined and its metal content from fewer operations the mining industry of Nevada showed an upward trend during 1928. White Pine County led in the value of the metals recorded and yielded over 71 per cent of the total value of the metals produced in the State in 1928, due to the large output of copper in the county. Four other counties each produced metals worth more than \$1,000,000: Lyon County, with its chief output in copper; Lincoln County, with the largest output of lead; Nye County, with its chief value in silver; and Elko County in fifth place, with its chief value in gold. Esmeralda, Lander, and Eureka Counties, each with an output valued at between \$600,000 and \$1,000,000, followed in order.

The total value of the mine production of gold, silver, copper, lead, and zinc in Nevada for 1904 to 1928, inclusive, as recorded in Mineral Resources, was \$684,833,026. Details of production are as follows: Ore, old tailings, etc., 94,615,903 short tons; gold, \$205,827,266; silver, 241,073,324 fine ounces (\$164,963,772); copper, 1,598,444,757 pounds (\$270,760,356); lead, 354,709,878 pounds (\$22,703,115); and zinc, 239,052,992 pounds (\$20,578,517).

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

¹ Work on manuscript completed November, 1929.

² The statistics for this report were collected and compiled under the supervision of C. N. Gerry, in the Salt Lake City office of the Bureau of Mines.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919-----	\$1.12	\$0.186	\$0.053	\$0.073	1924-----	\$0.670	\$0.131	\$0.080	\$0.065
1920-----	1.09	.184	.080	.081	1925-----	.694	.142	.087	.076
1921-----	1.00	.129	.045	.050	1926-----	.624	.140	.080	.075
1922-----	1.00	.135	.055	.057	1927-----	.567	.131	.063	.064
1923-----	.82	.147	.070	.068	1928-----	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in Nevada, 1919-1928

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919-----	384	37	3,187,831	219,695.16	\$4,541,502	6,863,580	\$7,687,210
1920-----	434	39	3,480,620	172,540.46	3,566,728	7,745,093	8,442,151
1921-----	370	61	1,096,138	160,254.62	3,312,757	7,083,782	7,083,782
1922-----	345	42	1,565,276	159,510.95	3,297,384	8,619,587	8,619,587
1923-----	354	35	4,354,937	204,292.89	4,223,109	10,614,564	8,703,942
1924-----	348	36	4,699,333	217,962.56	4,505,686	9,411,379	6,305,624
1925-----	399	25	4,927,139	187,104.72	3,867,798	7,096,618	4,925,053
1926-----	377	28	5,884,568	175,381.68	3,625,461	6,518,983	4,067,845
1927-----	379	30	5,531,152	150,346.16	3,107,931	5,397,179	3,060,200
1928-----	330	29	7,057,433	175,157.79	3,620,833	5,481,574	3,206,721

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919-----	52,331,175	\$9,733,599	15,349,370	\$813,517	9,004,698	\$657,343	\$23,433,171
1920-----	50,559,763	9,302,996	21,263,700	1,701,096	10,698,040	866,541	23,879,512
1921-----	10,961,491	1,414,032	7,188,768	323,495	69,397	3,470	12,137,536
1922-----	23,133,091	3,122,967	9,389,182	516,405	2,618,710	149,266	15,705,609
1923-----	67,204,282	9,879,029	18,156,337	1,270,944	14,166,550	963,325	25,040,349
1924-----	73,805,323	9,668,497	20,060,041	1,604,803	11,002,910	715,189	22,799,799
1925-----	79,300,224	11,260,632	24,476,452	2,129,451	14,821,293	1,126,418	23,309,352
1926-----	101,827,937	14,255,911	22,367,965	1,789,437	10,817,833	\$11,337	24,549,991
1927-----	120,259,276	15,753,965	15,784,818	994,444	6,344,523	406,049	23,322,539
1928-----	158,876,883	22,878,271	15,747,444	913,352	6,796,713	414,599	31,033,776

Gold and silver produced at placer mines in Nevada, 1919-1928

Year	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value
1919-----	6,399.43	\$132,288	2,374	\$2,659
1920-----	7,383.91	152,639	3,296	3,593
1921-----	17,566.99	363,142	7,956	7,956
1922-----	11,602.36	239,842	4,710	4,710
1923-----	3,941.83	81,485	1,783	1,462
1924-----	1,323.97	27,369	546	366
1925-----	2,536.54	52,435	1,285	892
1926-----	2,866.17	59,249	1,494	932
1927-----	1,809.22	37,400	740	419
1928-----	1,851.12	38,266	839	491

GOLD

The mine production of gold in Nevada increased from \$3,107,931 in 1927 to \$3,620,833 in 1928, chiefly on account of the enlarged output of copper ore from the mines at Ely. The Nevada Consolidated Copper Co. was by far the largest producer of gold in Nevada. Ore

was treated by amalgamation in 14 counties, and ore and old tailings were treated by cyanidation in 10 counties in 1928. By these two methods \$1,675,799 in gold was recovered from 305,718 tons of ore and 245,430 tons of old tailings. Most of the placer gold in 1928 was obtained by hydraulic and drift mining in the Round Mountain and Manhattan districts, Nye County, and by drift mining and rocker in the Battle Mountain district, Lander County. Amalgamation and cyanidation mills yielded 46 per cent of the total gold, concentrates 40 per cent (practically all in flotation concentrates), and crude smelting ore 13 per cent.

Nine properties supplied nearly 78 per cent of the total gold from Nevada in 1928, each producing more than 5,000 ounces. The Nevada Consolidated property at Ely was first, followed by the Elgoro at Jarbidge, the Consolidated Coppermines at Kimberly, the Goldfield Consolidated tailing dump (Bradshaw (Inc.)) at Goldfield, the Gold Circle Consolidated at Midas, the Tonopah Mining Co. at Tonopah, the Flowery at Virginia City, the White Caps at Manhattan, and the Tonopah Extension at Tonopah.

SILVER

In 1928 the mine production of silver in Nevada was 5,481,574 fine ounces, an increase of 84,395 ounces, compared with 1927. In Nye County 1,340,031 ounces of silver was contained in bullion recovered at amalgamation and cyanidation mills; most of this silver—1,337,039 ounces—was recovered by cyanidation. Concentrates recovered from ores produced in Nevada yielded 1,913,778 ounces of silver; 1,853,687 ounces was contained in flotation concentrate. Lead concentrates yielded 1,445,981 ounces of silver, an average recovery of 279.47 ounces a ton compared with 1,259,261 ounces, an average of 192.34 ounces, in 1927.

Ten properties, each producing more than 200,000 ounces, yielded 80 per cent of the total silver from Nevada in 1928. These properties, in order of output, were the Consolidated Cortez at Cortez, the Tonopah Mining at Tonopah, the Betty O'Neal near Battle Mountain, the Tonopah Extension at Tonopah, the Bristol Silver at Pioche, the Tonopah Belmont at Tonopah, the West End Consolidated at Tonopah, the Rochester Silver at Rochester, the Tonopah Divide at Divide, Esmeralda County, and the Elgoro at Jarbidge.

COPPER

In 1928 the mine production of copper in Nevada was 158,876,883 pounds, an increase of 32 per cent over 1927 and the largest output recorded for the State. The total value increased \$7,124,306, or 45 per cent, over 1927. Concentrates yielded nearly 91 per cent of the total copper, and crude ore shipped to smelters yielded 9 per cent. Flotation concentrate yielded 144,515,690 pounds and table concentrate only 34,482 pounds.

Three properties—the Nevada Consolidated Copper, the Consolidated Coppermines, and the Mason Valley Mines—yielded more than 96 per cent of the total copper from Nevada in 1928. The next largest producers were the Copper Canyon property near Battle Mountain and the Bristol Silver mine near Pioche.

LEAD

The mine production of lead in Nevada in 1928 was 15,747,444 pounds, a slight decrease (37,374 pounds) from the output in 1927. Concentrates recovered from milling ore and old tailings yielded 5,454,980 pounds, of which 3,093,603 pounds was recovered by flotation and 2,359,139 pounds by table concentration. The total crude ore of shipping grade yielded 10,284,619 pounds of lead, compared with 11,634,737 pounds in 1927.

Twelve mines yielded nearly 85 per cent of the total lead from Nevada in 1928. The Bristol Silver in Lincoln County was the largest producer, followed by the Combined Metals in Lincoln County, the Yellow Pine in Clark County, the Panther Mines in Elko County, the Richmond-Eureka in Eureka County, the Nevada Lead and Zinc and the American Beauty in Elko County, the Consolidated Cortez in Eureka County, the Silver Age in White Pine County, the Anchor mine in Clark County, the Betty O'Neal in Lander County, and the Chalk Mountain Silver-Lead in Churchill County.

ZINC

In 1928 the mine production of zinc in Nevada was 6,796,713 pounds, or 7 per cent more than in 1927. The Pioche district in Lincoln County produced 79 per cent of the total zinc output of the State and was followed by the Yellow Pine district, Clark County, which led in production in 1927. These were the only two districts producing zinc in 1928, with the exception of a small production from Humboldt County.

Two properties—the Combined Metals at Pioche in Lincoln County and the Yellow Pine at Goodsprings in Clark County—yielded nearly 95 per cent of the total zinc from Nevada in 1928. Sulphide zinc-lead ore from Pioche was treated by flotation in the plant of the Combined Metals Reduction Co. at Bauer, Utah; the resulting lead concentrate was shipped to International, Utah, and the zinc product to the electrolytic zinc plant near Great Falls, Mont. The Yellow Pine Mining Co. at Goodsprings shipped carbonate ore to eastern zinc plants up to the time its mill was destroyed by fire (June 10).

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1928, by counties

County	Gold				Silver (lode and placer)		
	Lode		Placer		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Churchill	138.35	\$2,860			\$2,860	4,687	\$2,742
Clark	749.52	15,494			15,494	27,805	16,266
Douglas	.15	3			3	12	7
Elko	28,643.80	592,120	3.68	\$76	592,196	474,601	277,642
Esmeralda	25,267.52	522,326	5.71	118	522,444	796,074	465,703
Eureka	2,692.93	55,668	22.79	471	56,139	816,512	477,659
Humboldt	1,058.06	21,872	13.88	287	22,159	20,378	11,921
Lander	766.65	15,848	303.89	6,282	22,130	604,153	353,429
Lincoln	1,120.85	23,170			23,170	671,473	392,812
Lyon	2,274.25	47,013			47,013	68,365	39,994
Mineral	2,459.00	50,832			50,832	45,890	26,846
Nye	27,061.12	559,403	1,383.86	28,607	588,010	1,414,285	827,357

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1928, by counties—Continued

County	Gold				Silver (lode and placer)	
	Lode		Placer		Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value		
Ormsby.....	2.66	\$55	-----	-----	49	\$29
Pershing.....	2,037.41	42,117	48.33	\$999	252,881	147,935
Storey.....	8,728.88	180,442	-----	-----	37,679	22,042
Washoe.....	220.45	4,557	-----	-----	2,295	1,343
White Pine.....	70,085.07	1,448,787	68.98	1,426	244,435	142,994
	173,306.67	3,582,567	1,851.12	38,266	5,481,574	3,206,721
Total, 1927.....	148,536.94	3,070,531	1,809.22	37,400	5,397,179	3,060,200

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Churchill.....	1,112	\$160	219,156	\$12,711	-----	-----	\$18,473
Clark.....	118,085	17,004	2,220,320	128,779	1,425,285	\$86,942	264,485
Douglas.....	7,527	1,084	-----	-----	-----	-----	1,094
Elko.....	457,297	65,851	2,677,446	155,292	-----	-----	1,090,981
Esmeralda.....	2,233	322	184,506	10,701	-----	-----	999,170
Eureka.....	51,199	7,373	1,296,707	75,209	-----	-----	616,380
Humboldt.....	989	142	6,785	394	1,248	76	34,692
Lander.....	3,113,822	448,390	375,791	21,796	-----	-----	845,745
Lincoln.....	2,100,779	302,512	7,652,815	443,863	5,370,180	327,581	1,489,938
Lyon.....	11,005,253	1,584,756	4,902	284	-----	-----	1,672,047
Mineral.....	22,971	3,308	51,000	2,958	-----	-----	83,944
Nye.....	2,020	291	64,538	3,743	-----	-----	1,419,401
Ormsby.....	991	143	-----	-----	-----	-----	227
Pershing.....	5,314	765	77,269	4,482	-----	-----	196,298
Storey.....	5,709	822	172	10	-----	-----	203,316
Washoe.....	5,503	793	184	11	-----	-----	6,704
White Pine.....	141,970,079	20,444,555	915,853	53,119	-----	-----	22,090,881
	158,876,883	22,878,271	15,747,444	913,352	6,796,713	414,599	31,033,776
Total, 1927.....	120,259,276	15,753,965	15,784,818	994,444	6,344,523	406,049	23,322,589

Ore, old tailings, etc., sold or treated, lode mines producing, and average value of ore, etc., in gold and silver in Nevada, 1927 and 1928, by counties

County	Ore, old tailings, etc. (short tons)		Lode mines producing		Average value per ton in gold and silver	
	1927	1928	1927	1928	1927	1928
Churchill.....	368	625	7	4	\$14.30	\$8.96
Clark.....	11,469	13,059	24	20	3.10	2.43
Douglas.....	54	250	3	1	20.00	.04
Elko.....	56,279	85,990	39	30	11.96	10.11
Esmeralda.....	220,759	301,307	39	36	4.99	3.28
Eureka.....	50,888	57,173	11	7	7.99	9.33
Humboldt.....	520	606	10	9	18.57	55.76
Lander.....	32,846	37,514	25	21	14.48	9.84
Lincoln.....	42,001	68,311	10	15	5.51	6.09
Lyon.....	427,000	565,508	21	17	.15	.15
Mineral.....	8,500	2,564	41	36	13.04	30.30
Nye.....	79,374	83,875	58	54	18.60	16.53
Ormsby.....	8	20	1	1	39.50	4.20
Pershing.....	25,419	30,847	20	12	5.68	6.16
Storey.....	81,827	76,441	20	19	3.31	2.65
Washoe.....	348	242	13	14	30.11	24.38
White Pine.....	4,493,492	5,733,101	37	34	.25	.28
	5,531,152	7,057,433	379	330	1.11	.96

Production of placer mines in Nevada in 1928, by counties

County	Mines		Gold	Silver (fine ounces)	Total value
	Drift	Hydrau- lic and sluicing			
Elko		1	\$76	-----	\$76
Esmeralda		1	118	2	119
Eureka		1	471	2	472
Humboldt		2	287	4	289
Lander	2	4	6, 282	51	6, 312
Nye	11	1	28, 607	760	29, 052
Pershing		3	999	8	1, 004
White Pine		3	1, 426	12	1, 433
Total, 1927	13	16	38, 266	839	38, 757
	6	24	37, 400	740	37, 819

MINING INDUSTRY

Increases in the quantity of gold, silver, copper, and zinc, together with increased prices for silver and copper in 1928, brought the total value of metals produced in Nevada in 1928 to \$31,033,776, compared with \$23,322,589 in 1927. The average price of zinc was only slightly less than in 1927, and that of lead also decreased. The quantity of ore and old tailings sold or treated in Nevada in 1928 was 7,057,433 tons, as compared with 5,531,152 tons in 1927.

Although the production of metal improved, no important discoveries of ore were recorded. Mining property was worked more vigorously in the central and western parts of Nevada for siliceous ore, and some ore was drawn from California through the operations of the Mason Valley smelter at Thompson. All available surface material sorted from old mine dumps, mills, and smelter sites found its way to Thompson during the year. Announcement in December that the Mason Valley copper smelter would close indefinitely came like a thunderbolt to miners who depended on its continued operation to market ores, usually of a grade too low to permit the cost of transportation to distant smelters. The smelter was blown in in January, 1912, and operated until October, 1914. Operation was resumed in February, 1917; two years later the smelter was closed down. Operation was again resumed in 1926 and the smelter was run continuously to the end of 1928; thereafter it was dismantled.

The list of companies operating in California indicated that many Nevada organizations had optioned California mining properties on which active development progressed during 1928. These companies included the Grandma Consolidated, Keystone Divide, Pay Divide, Tonopah North Star, Goldfield Consolidated Mines Co., MacNamara Crescent, MacNamara Mining, Rescue Eula, Yellow Tiger, Aladdin Divide, Myra Divide, Sunbeam Divide, Western Merger, Liberty Divide, Carrie Consolidated, and Revert.

The opening up of the Gold Ace or old Bull Moose property at Cararra, near Beatty, was interesting to collectors of beautiful specimen gold ore. A mill was constructed in October to treat the ore. The more substantial development of mines in the Tybo district by the Treadwell Yukon Co. was of importance to Nevada, and the renewal of active mining in the Spruce Mountain region,

which recorded an increased output of lead ore, was noted. In the vicinity of Pioche the increased output of milling and smelting ores had much to do with the gain in the total mineral production of the State.

Near Ely, in White Pine County, the Nevada Consolidated Copper Co. and the Consolidated Coppermines Co. prepared for deeper mining; these companies are the largest producers of copper in Nevada. In the Copper Basin region near Battle Mountain the Copper Canyon and Copper Queen mines were important producers of copper ore of shipping grade.

Of great interest was the opening of deposits of mercury ore in nine widely separated districts. Development of several of these deposits by improved methods of recovery has been reported profitable. The Relief and Antelope Springs districts in Pershing County proved most sensational, and one mine is said to have taken the lead in producing one-fourth of the mercury output of Nevada in 1928.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or recovered in Nevada, 1919-1928, with content in terms of recovered metals

DRY AND SILICEOUS ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	783,567	194,008.03	6,306,583	194,763	5,987,127	-----
1920.....	799,207	136,058.51	6,939,579	168,534	5,789,125	-----
1921.....	667,560	133,294.94	6,539,514	229,989	1,574,307	-----
1922.....	871,883	140,506.36	7,809,857	146,038	922,499	-----
1923.....	1,371,970	167,194.50	9,084,056	776,393	4,632,914	-----
1924.....	1,066,479	181,627.55	8,002,859	303,183	2,438,701	-----
1925.....	844,948	140,878.25	5,261,402	51,838	1,016,134	-----
1926.....	806,518	126,615.10	4,509,178	51,778	867,426	-----
1927.....	515,825	94,707.50	3,419,940	41,023	179,711	-----
1928.....	641,004	100,303.36	2,977,433	33,112	44,448	-----

COPPER ORE

1919.....	2,363,189	16,254.92	73,371	52,042,089	6,471	-----
1920.....	2,616,237	22,924.19	82,977	49,858,120	4,871	-----
1921.....	401,153	4,747.21	19,323	10,318,851	21	-----
1922.....	629,408	4,400.63	17,127	122,640,042	424	-----
1923.....	2,833,908	29,551.13	84,568	66,089,635	2,697	-----
1924.....	3,505,301	32,314.93	106,614	173,325,336	-----	-----
1925.....	3,923,158	35,515.84	125,477	178,795,059	-----	-----
1926.....	4,888,681	36,408.95	142,316	1100,870,898	1,417	-----
1927.....	4,885,052	46,883.96	183,525	1118,667,453	18	-----
1928.....	6,244,047	68,530.96	258,519	156,746,489	1,000	-----

LEAD ORE

1919.....	19,152	2,481.11	373,518	71,862	6,121,663	-----
1920.....	40,544	3,237.01	520,971	158,364	11,111,973	-----
1921.....	25,597	4,614.98	496,826	384,739	5,415,434	-----
1922.....	39,462	2,979.85	698,590	331,168	6,266,647	-----
1923.....	84,764	2,571.61	1,238,842	300,625	8,352,022	-----
1924.....	81,202	1,995.82	1,093,429	154,363	10,314,895	-----
1925.....	94,769	6,882.73	1,361,753	351,494	16,131,583	-----
1926.....	111,265	8,538.16	1,395,285	252,687	14,254,647	-----
1927.....	75,924	6,214.20	1,405,418	181,972	10,160,264	-----
1928.....	101,416	3,143.86	1,593,463	183,616	7,764,803	-----

¹ Includes copper saved from precipitates recovered from mine water.

Ore, old tailings, etc., sold or treated in Nevada, 1919-1928, with content in terms of recovered metals—Continued

COPPER-LEAD ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	4,996	511.52	3,345	24,871	92,413	-----
1920.....	6,269	2,936.41	114,358	374,745	1,340,286	-----
1921.....	1,689	30.50	20,163	27,912	154,288	-----
1922.....	102	1.90	2,153	11,283	39,869	-----
1923.....	330	708.16	13,089	21,769	60,558	-----
1924.....	3	.05	1,786	489	893	-----
1925.....	125	4.87	3,259	11,426	43,851	-----
1926.....	10,151	203.51	147,470	594,800	1,285,217	-----
1927.....	25,304	416.89	280,713	1,323,304	2,564,602	-----
1928.....	40,329	850.85	485,946	1,835,129	5,120,612	-----

ZINC ORE AND LEAD-ZINC ORE

Year	Ore, old tailings, etc.	Gold	Silver	Lead	Zinc
1919.....	16,927	40.15	104,389	590	3,141,696
1920.....	18,363	.43	83,912	-----	3,017,445
1921.....	139	-----	-----	-----	44,718
1922.....	24,421	19.85	87,150	4,560	2,159,743
1923.....	63,965	325.66	192,226	15,860	5,108,146
1924.....	46,348	700.24	206,145	21,952	7,305,552
1925.....	64,139	1,286.49	343,442	90,407	7,284,884
1926.....	67,953	749.79	323,240	57,774	5,959,258
1927.....	29,047	314.39	106,843	45,524	2,880,223
1928.....	30,637	477.64	165,374	78,537	2,816,581

Ore, old tailings, etc., sold or treated in Nevada in 1928, with content in terms of recovered metals

Source	Mines producing	Ore, old tailings, etc.		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore.....	142	1419,043	5.94	73,223.74	41.81	405,646	7.40
Dry gold and silver ore.....	22	275,297	1.07	2,911.02	1.66	117,733	2.15
Dry silver ore.....	56	3146,664	2.08	24,168.60	13.80	2,454,054	44.77
Copper ore.....	33	46,244,047	88.47	68,530.96	39.13	258,519	4.71
Lead ore.....	85	101,416	1.44	3,143.86	1.79	1,593,463	29.07
Zinc ore.....	1	34	-----	-----	-----	-----	-----
Copper-lead ore.....	4	40,329	.57	850.85	.48	485,946	8.86
Lead-zinc ore.....	8	30,603	.43	477.64	.27	165,374	3.02
Total, lode mines.....	330	7,057,433	100.00	173,306.67	98.94	5,480,735	99.98
Total, placers.....	29	-----	-----	1,851.12	1.06	839	.02
Total, 1927.....	359	7,057,433	100.00	175,157.79	100.00	5,481,574	100.00
	409	5,531,152	-----	150,346.16	-----	5,397,179	-----

¹Includes 243,580 tons of old tailings cyanided and 5 tons of clean-up material sold to a smelter.

²Includes 150 tons of old tailings cyanided, 73,336 tons of old tailings reconcentrated, and 162 tons of old tailings sold to a smelter.

³Includes 1 ton of clean-up material, 178 tons of sweepings sold to a smelter, and 1,700 tons of old tailings cyanided.

⁴Includes 250 tons of ore leached.

⁵A mine producing more than one class of ore is counted but once in arriving at total for all classes.

Ore, old tailings, etc., sold or treated in Nevada in 1928, with content in terms of recovered metals—Continued

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore.....	2,087	-----	4,420	0.03	-----	-----
Dry gold and silver ore.....	25,776	0.01	32,706	.21	-----	-----
Dry silver ore.....	5,249	-----	7,322	.05	-----	-----
Copper ore.....	156,746,489	98.66	1,000	-----	-----	-----
Lead ore.....	183,616	.12	7,764,803	49.31	-----	-----
Zinc ore.....	-----	-----	943	-----	19,394	0.29
Copper-lead ore.....	1,835,129	1.16	5,120,612	32.52	-----	-----
Lead-zinc ore.....	78,537	.05	2,815,638	17.88	6,777,319	99.71
Total, 1927.....	158,876,883	100.00	15,747,444	100.00	6,796,713	100.00
	^a 120,259,276	-----	15,784,818	-----	6,344,523	-----

^a Includes 189,554 pounds of copper saved from precipitates recovered from mine water, largely from leaching of ore in place.

Ore, old tailings, etc., sold or treated in Nevada in 1928, by counties, with gross and recovered metal content

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper		Lead		Zinc	
				Recovered	Gross	Recovered	Gross	Recovered	Gross
				Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Churchill.....	¹ 56	² 101.55	³ 63	-----	-----	-----	-----	-----	-----
Clark.....	810	169.80	690	-----	-----	162	170	-----	-----
Elko.....	73,456	28,516.83	356,710	-----	-----	-----	-----	-----	-----
Esmeralda.....	⁴ 247,224	17,751.73	8,168	-----	-----	210	221	-----	-----
Humboldt.....	443	1,052.30	8,453	158	166	-----	-----	-----	-----
Lander.....	437	592.00	1,262	510	532	2,048	2,157	-----	-----
Lincoln.....	79	98.40	366	55	57	2,000	4,000	-----	-----
Lyon.....	⁵ 3,793	1,201.60	6,285	-----	-----	-----	-----	-----	-----
Mineral.....	⁶ 1,649	1,824.04	5,149	282	297	-----	-----	-----	-----
Nye.....	⁷ 21,469	11,743.72	4,531	-----	-----	-----	-----	-----	-----
Pershing.....	702	322.06	1,195	-----	-----	-----	-----	-----	-----
Storey.....	⁸ 67,551	7,947.86	11,647	-----	-----	-----	-----	-----	-----
Washoe.....	190	209.51	79	-----	-----	-----	-----	-----	-----
White Pine.....	1,184	1,692.34	1,048	1,082	1,120	-----	-----	-----	-----
Total, 1927.....	419,043	73,223.74	405,646	2,087	2,172	4,420	6,548	-----	-----
	294,308	66,615.25	282,612	4,686	(⁹)	448	(⁹)	-----	-----

DRY GOLD AND SILVER ORE

Esmeralda.....	¹ 374	60.86	1,976	-----	-----	170	179	-----	-----
Lyon.....	² 65,194	1,072.35	49,785	17,118	18,668	1,244	1,310	-----	-----
Mineral.....	506	619.96	26,919	2,033	2,125	23,897	37,470	-----	-----
Nye.....	169	348.73	12,142	-----	-----	-----	-----	-----	-----
Storey.....	³ 8,890	778.22	25,833	5,709	5,969	172	181	-----	-----
Washoe.....	2	7.90	197	53	66	184	194	-----	-----
White Pine.....	⁴ 162	23.00	881	863	890	7,039	14,001	-----	-----
Total, 1927.....	75,297	2,911.02	117,733	25,776	27,718	32,706	53,335	-----	-----
	5,269	1,268.99	56,984	7,290	(⁵)	65,000	(⁶)	-----	-----

¹ Includes 242,140 tons of old tailings cyanided and 1 ton of clean-up material sold to a smelter.

² Includes 800 tons of old tailings cyanided.

³ Includes 100 tons of old tailings cyanided.

⁴ Includes 500 tons of old tailings cyanided and 4 tons of clean-up material sold to a smelter.

⁵ Includes 40 tons of old tailings cyanided.

⁶ Figures not available.

⁷ Includes 336 tons of old tailings reconcentrated.

⁸ Includes 65,000 tons of old tailings reconcentrated and 150 tons cyanided.

⁹ Includes 8,000 tons of old tailings reconcentrated.

¹⁰ Old tailings sold to a smelter.

Ore, old tailings, etc., sold or treated in Nevada in 1928, by counties, with gross and recovered metal content—Continued

DRY SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper		Lead		Zinc	
				Recovered	Gross	Recovered	Gross	Recovered	Gross
	Short tons	Fine ounces	Fine ounces	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Churchill	160	24.08	2,636						
Elko	34	14.00	14,874						
Esmeralda	53,476	7,432.34	777,763	256	276	124	131		
Eureka	27	12.00	789						
Humboldt	137	2.65	11,538	735	1,130	2,407	2,534		
Lander	54	20.39	1,487	567	597				
Lincoln	110		5,907	405	462	2,722	3,813		
Mineral	31	4.01	2,855	139	146	177	186		
Nye	11 60,881	14,946.68	1,386,403	310	328	125	132		
Pershing	30,015	1,707.52	243,791	1,753	2,017	1,767	1,859		
Storey		2.80	199						
Washoe	19	.64	1,294	391	407				
White Pine	12 1,720	1.49	4,518	693	715				
Total, 1927	146,664	24,168.60	2,454,054	5,249	6,078	7,322	8,655		
	216,248	26,823.26	3,080,344	29,047	(°)	114,263	(°)		

COPPER ORE

Clark	1,066	45.42	825	74,596	76,904				
Douglas	13 250	.15	12	7,527	7,923				
Elko	4,142	99.66	7,933	418,645	431,594	1,000	2,000		
Lander	12,066	86.33	4,489	3,071,080	3,228,620				
Lincoln	1,184		11,096	192,086	198,027				
Lyon	490,513		11,978	10,988,135	11,566,457				
Mineral	174	4.57	163	18,784	19,773				
Nye	3	1.78	24	774	815				
Ormsby	20	2.66	49	991	1,043				
Washoe	31	2.40	725	5,059	5,326				
White Pine	5,728,598	68,287.99	221,225	141,968,812	149,754,936				
Total, 1927	6,244,047	68,530.96	258,519	156,746,489	165,291,418	1,000	2,000		
	4,885,052	46,883.96	183,525	118,667,453	(°)	18	(°)		

LEAD ORE

Churchill	409	12.72	1,988	1,112	1,710	219,156	230,691		
Clark	6,792	217.51	23,464	37,460	47,381	1,697,224	1,786,551		
Elko	8,358	13.31	95,084	38,652	46,593	2,676,446	2,817,308		
Esmeralda	229	21.57	7,265	1,663	2,488	182,512	192,117		
Eureka	57,146	2,680.93	815,721	51,199	78,768	1,296,707	1,364,953		
Humboldt	3	.63	50	20	31	663	698		
Lander	24,957	67.93	596,864	41,665	63,628	373,743	393,414		
Lincoln	391	14.25	6,851	1,088	1,641	239,189	251,776		
Lyon	8	.30	317			3,658	3,850		
Mineral	204	6.42	10,804	1,733	2,665	26,926	28,343		
Nye	1,353	20.21	10,425	936	1,441	64,413	67,803		
Pershing	130	7.83	7,887	3,561	5,402	75,502	79,476		
White Pine	1,436	80.25	16,743	4,527	6,866	908,664	956,529		
Total, 1927	101,416	3,143.86	1,593,463	183,616	258,614	7,764,803	8,173,509		
	75,924	6,214.20	1,405,418	181,972	(°)	10,160,264	(°)		

COPPER-LEAD ORE

Clark	379	315.39	337	568	874	2,080	2,189		
Esmeralda	4	1.02	900	314	400	1,490	1,568		
Lincoln	39,945	534.44	484,701	1,834,145	2,157,818	5,116,892	5,386,202		
White Pine	1		8	102	127	150	158		
Total, 1927	40,329	850.85	485,946	1,835,129	2,159,219	5,120,612	5,390,117		
	25,304	416.89	280,713	1,323,304	(°)	2,564,602	(°)		

* Figures not available.

¹¹ Includes 1 ton of clean-up material and 178 tons of sweepings sold to a smelter.

¹² Includes 1,700 tons of old tailings cyanided.

¹³ Ore leached.

¹⁴ Includes 189,554 pounds of copper saved from precipitates recovered from mine water, largely from leaching of ore in place.

Ore, old tailings, etc., sold or treated in Nevada in 1928, by counties, with gross and recovered metal content—Continued

LEAD-ZINC ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper		Lead		Zinc	
				Recovered	Gross	Recovered	Gross	Recovered	Gross
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Clark.....	3, 978	1. 40	2, 489	5, 461	7, 714	519, 911	708, 302	1, 405, 891	1, 757, 364
Humboldt....	23	2. 48	333	76	108	3, 715	3, 941	1, 248	1, 434
Lincoln.....	26, 602	473. 76	162, 552	73, 000	90, 000	2, 292, 012	2, 708, 473	5, 370, 180	6, 151, 419
Total, 1927....	30, 603	477. 64	165, 374	78, 537	97, 822	2, 815, 638	3, 420, 716	6, 777, 319	7, 910, 217
	27, 582	314. 39	106, 843	45, 524	(^e)	2, 880, 223	(^e)	5, 427, 415	(^e)

^e Figures not available.

Zinc ore, lead-zinc ore, zinc concentrates, and lead-zinc concentrates (as marketed from Nevada mines and mills) sold to smelters in 1928

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of ore or concentrates	Recovered zinc
		<i>Short tons</i>	<i>Pounds</i>	<i>Per cent</i>	<i>Pounds</i>
Oxidized zinc ore.....	Clark.....	34	24, 242	35. 65	19, 394
Oxidized lead-zinc ore.....	do.....	2, 733	1, 638, 417	29. 97	1, 310, 733
Zinc concentrates.....	Humboldt and Lincoln.....	6, 050	6, 152, 853	50. 86	5, 371, 428
Lead-zinc concentrates.....	Clark.....	161	118, 947	36. 84	95, 158
		8, 978	7, 934, 459	44. 19	6, 796, 713

METALLURGIC INDUSTRY

In 1928 the metal output came chiefly from the smelting of concentrates and first-class ore, as both showed an increase in tons of material treated. Comparing the output with that of 1927 there was a decrease in the quantity of each metal, except copper, recovered from crude smelting ore, a decrease in the total yield of metals from gold and silver mills, and an increase in the quantity of each metal recovered from concentrates, chiefly by flotation.

Seventy-two milling plants in Nevada treated ore and old tailings in 1928. Of these, 31 used the amalgamation process, 17 concentration (12 used flotation, 1 tables and flotation, and 4 tables only), 15 cyanidation, 1 amalgamation and cyanidation, 5 amalgamation and concentration, and 2 amalgamation, cyanidation, and concentration; 1 was an experimental leaching plant.

A list of the milling plants, with details of their equipment, in Nevada in 1925, prepared by the Bureau of Mines, may be had upon request.

Nine hundred and five pounds of quicksilver was reported purchased for amalgamation plants, and 776,570 pounds of sodium cyanide was used in cyanidation mills.

The output of milling ore and old tailings in 1928 was 6,823,466 tons, of which 305,718 tons of ore and 245,430 tons of old tailings were treated by amalgamation or cyanidation and 6,198,982 tons of ore and 73,336 tons of old tailings by concentration followed by smelting. The ore and old tailings treated by cyanidation (527,511 tons) yielded on the average \$2.85 in gold and 5.16 ounces of silver

to the ton. The ore amalgamated (23,637 tons) yielded bullion averaging \$7.27 in gold and 0.36 ounce of silver to the ton. Of the total ore and other material 88 per cent was of concentrating grade and produced concentrates which, with those from gold and silver mills, yielded on the average \$63.79 in metals a ton.

The ore of smelting grade represented more than 3 per cent of the total quantity of ore and other material mined or treated, and 69 per cent of it was first-class copper ore; the remainder was mainly copper-lead ore, dry and siliceous ore, and lead ore. The quantity of copper ore smelted in 1928 increased 25 per cent over 1927. The copper-lead ore of smelting grade, all of which was oxidized, increased from 25,304 tons in 1927 to 39,950 tons in 1928. The lead ore of smelting grade, more than half of which was oxidized, decreased 42 per cent in 1928. The quantity of lead-zinc ore smelted decreased from 4,711 tons in 1927 to 2,733 tons in 1928.

The cyanide extraction of gold and silver associated with arsenic and antimony ores, with especial reference to those in Nevada and South Dakota, was recently described by the Bureau of Mines in Technical Paper 423.

The miscellaneous material, other than ore and old tailings milled and crude ore smelted, was not important.

Mine production of metals from gold and silver mills in Nevada in 1928, by counties

County	Ore and old tailings treated		Recovered in bullion			
			Amalgamation		Cyanidation	
	Ore	Old tailings	Gold	Silver	Gold	Silver
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Churchill.....	160	-----	22.74	2,487	-----	-----
Clark.....	803	-----	53.97	517	4.11	14
Elko.....	73,452	-----	590.41	449	27,908.66	356,198
Esmeralda.....	54,693	242,140	27.19	49	20,789.95	776,149
Humboldt.....	341	-----	269.00	84	-----	-----
Lander.....	226	-----	51.87	56	76.41	108
Lincoln.....	3	-----	4.41	3	-----	-----
Lyon.....	2,830	950	656.71	530	375.84	5,058
Mineral.....	552	100	171.82	96	224.01	271
Nye.....	74,248	500	4,873.88	2,992	14,759.56	1,337,039
Pershing.....	30,475	-----	190.89	136	1,652.06	231,677
Storey.....	67,527	40	943.79	940	6,963.42	10,239
Washoe.....	190	-----	209.41	79	-----	-----
White Pine.....	218	1,700	245.18	59	1.49	4,241
Total, 1927.....	305,718	245,430	8,311.27	8,477	72,755.51	2,720,994
	322,530	140,060	6,733.11	4,157	68,994.15	3,624,943

County	Concentrates and metal (gross and recovered)				
	Concentrates produced	Gold	Silver	Lead	
				Recovered	Gross
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Churchill.....	1	1.34	149	-----	-----
Clark.....	3	20.70	104	162	170
Esmeralda.....	5	26.45	190	210	221
Lander.....	2	.91	194	1,696	1,786
Pershing.....	1	15.90	76	-----	-----
Storey.....	2	2.80	199	-----	-----
Total, 1927.....	14	68.10	912	2,068	2,177
	1563	189.35	150,906	80,895	(2)

¹ Yielded also 6,069 pounds of copper.

² Figures not available.

Mine production of metals from concentrating mills in Nevada in 1928, by counties

County	Ore and old tailings treated		Concentrates and metal (gross and recovered)		
	Ore	Old tailings	Concentrates produced	Gold	Silver
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Clark	7,865		1,421	317.27	22,662
Elko	5,043		1,058		34,664
Esmeralda		336	6	45.33	1,430
Eureka	51,167		1,540	443.22	785,980
Humboldt	159		38	5.08	11,691
Lander	24,749		1,282	53.76	584,809
Lincoln	26,802		9,261	484.17	165,360
Lyon	475,848	65,000	42,361	1,025.70	60,751
Mineral	186		31	1.31	10,300
Nye	1,203		59	6.08	10,302
Storey		8,000	112	415.54	12,721
White Pine	5,605,960		319,448	66,871.60	212,196
Total, 1927	6,198,982	73,336	376,617	69,669.06	1,912,866
	4,833,030	35,005	326,440	47,434.44	1,336,721

County	Concentrates and metal (gross and recovered)—Continued					
	Copper		Lead		Zinc	
	Recovered	Gross	Recovered	Gross	Recovered	Gross
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Clark	35,075	44,056	1,311,934	1,387,750	95,158	118,947
Elko	167	209	1,156,786	1,217,665		
Esmeralda			170	179		
Eureka	25,031	38,509	364,617	383,807		
Humboldt	811	1,238	6,122	6,475	1,248	1,434
Lander	40,961	62,545	249,950	263,105		
Lincoln	73,000	90,000	2,328,301	2,746,672	5,370,180	6,151,419
Lyon	10,218,851	10,757,334	1,244	1,310		
Mineral	682	1,049	14,658	15,429		
Nye	369	568	19,130	20,137		
Storey	4,205	4,384				
White Pine	134,151,020	141,509,494				
Total, 1927	144,550,172	152,509,386	5,452,912	6,042,529	5,466,586	6,271,800
	109,325,137	(¹)	4,004,089	(¹)	3,355,178	(¹)

¹ Figures not available.*Mine production of metals from Nevada concentrates in 1928*

BY COUNTIES

	Concentrates	Gold	Silver	Copper		Lead		Zinc	
				Recovered	Gross	Recovered	Gross	Recovered	Gross
		<i>Short tons</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Churchill	1	1.34	149						
Clark	1,424	337.97	22,766	35,075	44,056	1,312,096	1,387,920	95,158	118,947
Elko	1,058		34,664	167	209	1,156,786	1,217,665		
Esmeralda	11	71.78	1,620			380	400		
Eureka	1,540	443.22	785,980	25,031	38,509	364,617	383,807		
Humboldt	38	5.08	11,691	811	1,238	6,122	6,475	1,248	1,434
Lander	1,284	54.67	585,003	40,961	62,545	251,640	264,891		
Lincoln	9,261	484.17	165,360	73,000	90,000	2,328,301	2,746,672	5,370,180	6,151,419
Lyon	42,361	1,025.70	60,751	10,218,851	10,757,334	1,244	1,310		
Mineral	31	1.31	10,300	682	1,049	14,658	15,429		
Nye	59	6.08	10,302	369	568	19,130	20,137		
Pershing	1	15.90	76						
Storey	114	418.34	12,920	4,205	4,384				
White Pine	319,448	66,871.60	212,196	134,151,020	141,509,494				
Total, 1927	376,631	69,737.16	1,913,778	144,550,172	152,509,386	5,454,980	6,044,706	5,466,586	6,271,800
	327,003	47,623.79	1,487,627	109,331,206	(¹)	4,084,984	(¹)	3,355,178	(¹)

¹ Figures not available.

Mine production of metals from Nevada concentrates in 1928—Continued

BY KINDS OF CONCENTRATES

	Con- cen- trates	Gold	Silver	Copper		Lead		Zinc	
				Recovered	Gross	Re- covered	Gross	Re- covered	Gross
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	985	1,561.45	78,573	22,922	25,073	4,193	4,414	-----	-----
Copper.....	360,989	66,871.23	223,513	144,351,889	152,247,269	5,237,445	5,779,547	-----	-----
Lead.....	8,437	813.82	1,577,274	115,501	165,759	2,080	2,189	-----	-----
Copper-lead.....	9	315.39	337	568	874	18,003	25,718	-----	-----
Zinc.....	6,050	175.27	34,081	59,022	70,025	193,259	232,838	5,371,428	6,152,853
Lead-zinc.....	161	-----	-----	270	386	-----	-----	95,158	118,947

Mine production of metals from Nevada crude ore shipped to smelters in 1928

BY COUNTIES

	Ore	Gold	Silver	Copper		Lead		Zinc	
				Re- covered	Gross	Re- covered	Gross	Re- covered	Gross
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Churchill.....	465	114.26	2,051	1,112	1,710	219,156	230,691	-----	-----
Clark.....	4,391	353.49	4,508	83,010	88,817	908,224	1,110,639	1,330,127	1,662,659
Elko.....	7,495	144.76	83,290	457,130	477,978	1,520,660	1,601,643	-----	-----
Esmeralda.....	4,137	4,373.45	18,248	2,233	3,164	184,126	193,816	-----	-----
Eureka.....	6,006	2,249.70	30,530	26,168	40,259	932,090	981,146	-----	-----
Humboldt.....	106	783.98	8,599	178	197	663	698	-----	-----
Lander.....	12,539	583.66	18,935	3,072,861	3,230,832	124,145	130,680	-----	-----
Lincoln.....	41,506	632.28	506,110	2,027,779	2,358,005	5,324,514	5,607,592	-----	-----
Lyon.....	20,880	216.01	2,026	786,402	827,791	3,658	3,850	-----	-----
Mineral.....	1,726	2,061.88	35,223	22,289	23,957	36,342	50,570	-----	-----
Nye.....	7,920	7,395.78	63,124	1,651	2,016	45,408	47,798	-----	-----
Ormsby.....	20	2.68	49	991	1,043	-----	-----	-----	-----
Pershing.....	193	128.51	12,209	4,756	6,721	76,424	80,446	-----	-----
Storey.....	874	403.34	13,580	1,504	1,585	172	181	-----	-----
Washoe.....	52	11.03	2,216	5,503	5,799	184	194	-----	-----
White Pine.....	125,061	2,943.80	27,046	7,824,196	8,254,270	908,853	956,688	-----	-----
Total, 1927.....	233,371	22,398.61	827,744	14,317,763	15,324,144	10,284,619	10,996,632	1,330,127	1,662,659
	199,077	25,004.34	870,906	10,731,357	(1)	11,634,737	(1)	2,989,345	(1)

BY KINDS OF ORE

Dry and siliceous.....	16,035	17,570.15	159,465	8,769	9,307	30,714	47,489	-----	-----
Copper.....	161,989	1,659.69	34,994	12,387,073	13,036,226	1,000	2,000	-----	-----
Lead.....	12,630	2,633.31	147,676	82,659	113,550	4,723,100	4,971,682	-----	-----
Copper-lead.....	39,950	535.46	485,609	1,834,561	2,158,345	5,118,532	5,387,928	-----	-----
Zinc.....	34	-----	-----	-----	-----	943	1,347	19,394	24,242
Lead-zinc.....	2,733	-----	-----	4,701	6,716	410,330	586,186	1,310,733	1,638,417

¹ Figures not available.

REVIEW BY COUNTIES AND DISTRICTS

As the detailed review of the districts was omitted from the report of this series for 1927, the production of the important districts for that year has been inserted in the following review.

CHURCHILL COUNTY

Desert district.—The Last Chance group, which produced gold ore in 1927, did not produce in 1928.

Fairview and Eagleville districts.—The combined output of three mines in the Fairview and Eagleville districts in 1928 was 465 tons of ore, yielding \$2,362 in gold, 2,051 ounces of silver, 1,112 pounds of copper, and 219,156 pounds of lead, valued in all at \$16,433. All

of the output was first-class smelting ore; most of it came from the Chalk Mountain Silver-Lead Mines Co. The mine was operated the entire year and is opened by a vertical shaft 517 feet deep and by 5,000 feet of drifts. About 1,000 feet of development was done in 1928. During the year a 75-ton rod mill was constructed.

Sandsprings district.—During the past two years the gold ore produced from the Dan Tucker group, operated by lessees, was treated and amalgamated in an Ellis Ball mill. Some concentrate, containing gold and silver, was saved.

CLARK COUNTY

Charleston district.—No operations were reported from the Charleston district for 1928. A car of high-grade sulphide lead ore was shipped from the Crescent group, 3 miles north of Charleston Peak, in 1927.

Copper King district (Bunkerville).—The Key West mine, 15 miles south of Bunkerville in the Virgin Range, has been an occasional producer of copper ore containing nickel, cobalt, platinum, and a little gold and silver. The occurrence of nickel in the district was known as early as 1901 and the Key West property was worked about 1903. In 1906 the presence of platinum in the ore was known, and the Great Eastern property, as well as the Key West, was prospected.³ The district has not been active in recent years until in 1928, when about 1,000 tons of ore was shipped to a smelter for reduction.

Eldorado Canyon district.—In 1928 three lode mines in the Eldorado Canyon district produced 1,183 tons of ore, yielding \$9,686 in gold, 1,000 ounces of silver, 568 pounds of copper, and 2,242 pounds of lead, valued in all at \$10,483, or \$8.86 in metals a ton. In 1927 a larger output from the same number of lode mines was valued at \$21,587, or \$18.69 in metals a ton. Gold and silver and some concentrate were recovered in milling plants of the Eldorado-Rand and Techatticup properties.

Searchlight district.—In 1928 three lode mines in the Searchlight district produced 77 tons of ore, yielding \$4,626 in gold, 252 ounces of silver, 1,929 pounds of copper, and 8,991 pounds of lead, valued in all at \$5,573, or \$72.38 in metals a ton. In 1927 the output from four properties was 106 tons of ore with a total value in metals of \$7,940, or \$74.91 a ton. The principal production in 1928 came from the Duplex mine, operated by lessees. A little ore was treated by cyanidation at the Pompeii property.

Sunset district.—In 1928 the Lucy Gray mine produced a small lot of gold ore which was shipped to a smelter. Its cyanide plant was idle.

Yellow Pine district (Goodsprings).—The output of the Yellow Pine district was about the same in 1928 as in 1927, with fewer producers. In 1928, 10,745 tons of ore yielded \$140 in gold, 25,793 ounces of silver, 43,955 pounds of copper, 2,209,087 pounds of lead, and 1,425,285 pounds of zinc, valued in all at \$236,627, or \$22.02 in metals a ton. In 1927, 16 lode mines produced 10,192 tons of ore with a total value in metals of \$339,311, or \$33.29 a ton. The ore of smelting grade shipped in 1928 amounted to 3,259 tons and yielded 4.89 ounces of gold, 3,468 ounces of silver, 9,448 pounds of copper, 899,233 pounds of lead, and 1,330,127 pounds of zinc. The Yellow Pine Mining Co. was the largest producer of lead-zinc ore, which was shipped to an

³Bancroft, H., *Platinum in Southeastern Nevada*: U. S. Geol. Survey Bull. 782, 1910, pp. 192-199.

eastern smelter. Its 50-ton concentrator⁴ was entirely destroyed by fire on June 10. Up to the close of operations 5,846 tons of oxidized lead-zinc ore was concentrated at a cost of \$1.059 a ton. The mill heads averaged 15.31 per cent of lead, 15.97 per cent of zinc, and 5.4 ounces of silver a ton, and the ratio of concentration was 5.37 tons into 1. The recovery of lead was 66.08 per cent. After concentration of the ore 1,088 tons of lead concentrate was shipped, containing 54.36 per cent of lead, 9.22 per cent of zinc, and 17.35 ounces of silver to the ton. The tailing, of which 4,758 tons was produced, contained 6.38 per cent of lead, 17.52 per cent of zinc, and 2.67 ounces of silver to the ton.

In addition to lead concentrate 146 tons of lead ore assaying 39.06 per cent of lead and 7.27 ounces of silver a ton was sold to a lead smelter, and 2,289 tons of mixed ore containing 13.65 per cent of lead and 29.19 per cent of zinc was sold to the Grasselli Chemical Co. The total net value of the ore and concentrates sold in 1928 was \$94,233. Development work in the mine disclosed two new ore bodies—one in the central portion of the mine above the 200-foot level and the other in the northern section about the 600-foot level. Oxidized lead ore and lead-zinc ore was produced from the Anchor, Hoosier, Milford and Addison, and the Yellow Pine properties; copper ore was produced from the Columbia claim; and some oxidized lead ore was produced from the Lucky Bugg. The Argentina Consolidated operated a small mill during part of 1928 and was reported to have shipped some lead and some lead-zinc concentrate. The Potosi mine, a producer in 1927, was not reported as a shipper of ore in 1928.

DOUGLAS COUNTY

Gardnerville district.—A small leaching plant on the Ruby Hill property in the Gardnerville district was operated in 1928 by the Johnstone Engineering Co., and copper precipitates assaying about 75 per cent of copper were shipped to the Mason Valley smelter.

ELKO COUNTY

Contact district (Salmon River).—Four lode mines in the Contact district shipped 4,142 tons of ore in 1928, yielding \$2,060 in gold, 7,933 ounces of silver, 418,645 pounds of copper, and 1,000 pounds of lead, valued in all at \$67,044, or \$16.19 in metals a ton. Most of the ore was produced from the Delano claims of the Seattle Contact Copper Co. This property is opened by a vertical shaft 240 feet deep and a tunnel 2,500 feet long. Shipments of ore were also made from the Palo Alto, from the Queen of the Hills, and from the property operated by the Gray Mining Co.

Delano district.—From the Net No. 2 claim of the Panther Mines Co. 4,449 tons of ore was produced in 1928; 706 tons of this ore, which averaged 32 ounces of silver to the ton and 27 per cent of lead, was shipped direct to a smelter. The 50-ton concentrator on the property treated 3,743 tons of ore, from which was produced 628 tons of concentrates; the concentrate averaged 60 ounces of silver and 45 per cent of lead. From the Blue Bell mine 42 tons of lead-silver ore was shipped to a smelter the latter part of 1928.

⁴ Yellow Pine Mining Co. Annual Report for year ended Dec. 31, 1928.

Falcon district (Rock Creek).—The April Fool group of claims, 12 miles west of Tuscarora in the Falcon district, produced a rich lot of ore in 1928 assaying \$7.70 in gold and 428 ounces of silver to the ton. Most of the ore shipped to the smelter in 1928 came from sinking prospect shafts on the Walker and Young discoveries.

Gold Circle district (Midas).—Five producers of ore reported the treatment of 26,170 tons of ore in 1928, largely by cyanidation. The bullion from this ore yielded \$169,770 in gold and 149,026 ounces of silver, valued together at \$256,950, or \$9.82 in metals a ton. The output of the district became important in 1927 through the operations of the Gold Circle Consolidated Mines Co., which took over the Elko Prince, Rex, Colorado Grandes, Grant, and Link groups. The company's property has been extensively developed and a 75-ton cyanidation plant of the all-sliming countercurrent decantation type was constructed in 1927; the plant was put in operation in June of that year. Gold ore was also produced from the Black Cloud, Esperanza, Queen, and Golden Chariot claims. The Coot custom amalgamation plant treated some of the ore from mines in the district.

Island Mountain district.—Some gold ore from the Gold Center property of the Island Gold Mines Co. was treated in 1928 in a plant equipped with a ball mill, Wilfley tables, and amalgamation plates. A small lot of ore and concentrate was shipped to a smelter.

Jarbidge district.—In 1928 three lode mines in the Jarbidge district produced 47,281 tons of ore containing gold and silver. In February, 1927, the United Eastern Mining Co. relinquished its property in the district; before discontinuing operations the company produced considerable bullion from the Bluster, Success, and Pick & Shovel groups. The Elkoro Mines Co., a subsidiary of the Yukon Gold Co., according to its annual printed report for 1928, mined and milled 46,400 tons of ore averaging \$11.38 a ton in gold and silver, with a recovery value of \$527,800. The total cost of mining and milling, excluding depreciation and development, was \$236,500, or \$5.10 a ton. Ore reserves in this property are small, but considerable attention was given to opening up the recently discovered Mill Tunnel ore body and North Hike vein. Enough ore for several years' operation is assured.

Merrimac district.—The Rip Van Winkle mine, operated by lessees in 1927 and 1928, produced lead-silver ore of shipping grade.

Mud Springs district.—The Silver Butte Consolidated Mining Co., operating in 1927 and 1928, shipped from its property sulphide lead ore carrying silver. A concentrating mill, under construction, using oil flotation, is expected to start operation in May, 1929.

Railroad district.—No ore was reported produced in the Railroad district in 1928, but in 1927 several small lots of ore valued at \$2,182 were shipped from five lode mines; one lot of copper-lead ore was shipped by a lessee from the Nevada Bunker Hill property and the remainder consisted of small lots from dumps or prospects.

Rowland district.—The Bruneau Mining Co. treated 200 tons of gold ore in 1927 in a 20-ton stamp (amalgamation) mill. The mine was closed in July, 1927, and no activity was manifested by the company in 1928.

Ruby Mountain Range district.—The American Beauty mine was the principal producer in the Ruby Mountain Range district in 1927 and 1928. Lead concentrate was recovered in a mill on the property; the mill is equipped with rolls and 4-compartment jigs.

Spruce Mountain district.—All the ore produced from the six lode mines in the Spruce Mountain district in 1928 was of shipping grade and amounted to 2,430 tons, yielding \$235 in gold, 30,811 ounces of silver, 38,464 pounds of copper, and 1,057,670 pounds of lead, valued in all at \$85,144, or \$35.04 in metals a ton. This output compares with 2,902 tons of ore produced in 1927, yielding \$540 in gold, 52,560 ounces of silver, 24,332 pounds of copper, 1,271,234 pounds of lead, and 40,197 pounds of zinc, valued in all at \$116,190, or \$40.04 in metals a ton. The entire 1927 output was first-class lead ore with the exception of 165 tons of ore, which was concentrated. The chief producers in both years were the Nevada Lead & Zinc, Spruce Monarch, and Black Forest properties. The Spruce Standard Mining Co., operating the Ada H group, was important as a producer of lead-silver ore; several lots of lead-silver ore were also shipped from Jasper, on the Western Pacific Railroad, for the Bullshead Mining & Smelting Co. Late in 1928 the Missouri Monarch Mines Co. took over the holdings of the Spruce Monarch Lead & Silver Mining Co. and commenced operations by construction of new buildings and prepared for development of ore. From the Kille mines, under development by the Nevada Lead & Zinc Co., considerable silver-lead ore was shipped in 1928.

Tecoma district.—In 1927 oxidized lead ore was shipped by lessees from the Jackson group in the Tecoma district, but none was shipped in 1928.

Tuscarora district.—In 1928 a lessee working in the Nevada mine, one of the old properties in the Tuscarora district, shipped a ton of very rich gold ore to a smelter.

Warm Creek district.—The Polar Star mine, operated by lessees, produced one car of lead ore in the Warm Creek district in 1927; no ore was shipped from the district in 1928.

ESMERALDA COUNTY

Castle Rock district.—In 1928 two small lots of silver ore were shipped from the New Alta Divide property and rich gold ore from the Hatch and Logan claims. Some of the ore containing gold and silver was sold to the Mason Valley smelter and some was treated at cyanidation plants near Tonopah. Ore trucked to the railroad cost \$2 a ton, freight to Tonopah 85 cents a ton, and milling \$20 ore \$4 a ton. Mining the ore cost \$6.85 a ton. The Castle Rock district is 8 miles north of Blair Junction. It was not a producer of ore in 1927.

Desert district (Gilbert).—In 1927 and 1928 the Last Hope and Black Mammoth groups in the Desert district were operated by lessees who shipped gold-silver ore which was treated at the cyanidation plant near Tonopah. One small lot of ore containing silver and lead was shipped from the Carrie mine to a smelter.

Divide (Gold Mountain) district.—In 1928 eight lode mines in the Divide district produced 10,841 tons of ore yielding \$46,988 in gold and 247,417 ounces of silver, valued together at \$191,727, or \$17.69 in metals a ton. In 1927 the output amounted to 7,630 tons of ore with a total value in gold and silver of \$175,802, or \$23.04 in metals a ton. Most of the ore of milling grade for both years was mined from the Tonopah Divide and Brougher Divide mines. The Mason Valley smelter bought 198 tons of siliceous ore mined in the district in 1928. At the Brougher Divide property a new shaft was sunk in

1927 and more than 1,600 tons of siliceous ore was shipped to Millers, near Tonopah. At the same time small lots of rich silver-lead ore were shipped to a smelter from the Hasbrouck mine and siliceous gold ore from the Reorganized Belcher and Verde Divide properties.

Goldfield district.—Ore from four lode mines and old tailing from the Goldfield dump yielded \$279,373 in gold and 4,553 ounces of silver in 1928. The output of the Goldfield district consisted of 681 tons of gold and silver ore shipped to cyanidation plants near Tonopah and 674 tons of siliceous ore shipped to the Mason Valley smelter at Thompson. The tailing re-treated was from a dump of about 1,500,000 tons accumulated over a period of about six years operation of the Goldfield Consolidated Mines Co. The Bradshaw (Inc.) owns the lease and worked 242,000 tons of the tailing; in 1928 it ranked fourth in the output of gold and in 1927 it ranked sixth. To treat this tailing most of the old milling equipment of the Goldfield Consolidated mine was put to good use; operations started in June, 1927, and to the end of the year 136,000 tons of slimes and tailing were cyanided, yielding 7,057.76 ounces of gold, 5,080 ounces of silver, and 5,980 pounds of copper, valued in all at \$149,560. The tailing is washed into a pit and pumped up to the mill. Operations are confined to seasonable weather, as the material treated balls up when cold. The Goldfield Consolidated mine is kept open for lessee operations, from which the company receives a royalty justifying its operation. Siliceous ore, containing gold, from the Florence mine was shipped during 1927 and 1928 by lessees to the Tonopah cyanidation plant and the Mason Valley smelter. At the Goldfield Deep Mines two drifts were started in November, 1928, on the 2,150-foot level, where ore said to contain copper and gold valued at \$40 a ton was found.

Hornsilver district.—No ore was reported from the Hornsilver district in 1928; seven lode mines in 1927 produced 157 tons of ore yielding \$2,224 in gold and 1,817 ounces of silver, valued together at \$3,254, or \$20.73 in metals a ton. All the output was treated at gold and silver mills by cyanidation with the exception of 8 tons of first-class ore shipped to a smelter. The Southwestern property of the Nevada Silver Mines Corporation was worked a short time by a lessee. Small lots of ore were shipped from the Black Wonder Silver King, and Hornsilver Contact properties.

Klondyke district.—The output of the Klondyke district consisted of two cars of gold-silver ore shipped to cyanidation plants in 1927. In 1928 the output was not much greater. The principal production came from the Original Klondyke property, which was operated in both 1927 and 1928.

Lone Mountain district.—Three lode mines in the Lone Mountain district produced 42 tons of ore in 1928, compared with 884 tons produced by five lode mines in 1927. The 1927 output yielded \$9,052 in gold, 2,137 ounces of silver, 148 pounds of copper, 4,123 pounds of lead, and 3,142 pounds of zinc, valued in all at \$10,744, or \$12.15 in metals a ton. Most of this ore was treated at custom plants by cyanidation and came from the Weepah group, operated by the Electric Gold Mines Co. One car of lead-zinc ore was shipped from the General Thomas mine for custom milling, and one car of silver ore from the Whittier property in the Paymaster Canyon was treated by cyanidation. Several lots of gold ore were shipped to the custom

plant of the Silver Peak Reduction Co. at Silverpeak and treated by cyanidation and concentration.

Montezuma district.—The Monitor mine of the Harmill Divide Co. was worked a short time under lease in 1927 and 1928 and each year shipments of silver-lead ore went to Utah for smelting.

Palmetto district.—No production was made in the Palmetto district in 1928. In 1927 a small lot of gold ore was shipped from the Palmetto claim, which is opened by various shafts to a depth of 400 feet.

Silver Peak district.—In 1928 eight operators of lode mines in the Silver Peak district reported the production of 4,205 tons of ore and old tailings which yielded \$81,463 in gold, 4,632 ounces of silver, and 388 pounds of lead, valued in all at \$84,195, or \$20.02 in metals a ton. The Mary mine, the largest producer of gold and silver in the district, continued to be operated by the Lucky Boy Divide Mining Co. and at one time 9 lessees were operating. Part of the ore produced in the district was treated locally at concentration and cyanidation plants, some was sent by auto trucks to the custom cyanidation plant near Tonopah, and the remainder was shipped direct to the smelter at Thompson. The Valcalda property was operated by the Oromonte Mines Co., which reports the operation of a 20-ton custom mill equipped for amalgamation, concentration, and flotation. Other shipments of ore and concentrate originated from the Laddie group of the Black Mammoth Mining Co. and the Nivloc property.

Sylvania district.—The Sylvania district is near the California-Nevada border, 12 miles southeast of Oasis, Calif. In 1928 the Bowser group and Hard Times claim, worked by the Oasis Mining Co., produced lead ore which was shipped to a smelter in Utah.

Tonopah district.—The output of ore in 1928 from the western part of the Tonopah district in Esmeralda County continued to increase. Two lode mines were operated in 1928, compared with three in 1927. An increase in output has occurred in each of the past three years. The figures of output are included in the Tonopah district review under Nye County. In 1927 some ore was produced from the West End Extension property, but in 1928 only the Tonopah "76," of the West End Consolidated Mining Co., and the Tonopah Extension Mines were producers.

EUREKA COUNTY

Cortez district.—The Consolidated Cortez mine in the Cortez district ranked first in the production of silver in Nevada in 1928; in 1927 it ranked fourth. In 1927 about 60 per cent of the ore was treated by cyanidation and table concentration; beginning in September, 1927, the ore was treated by flotation, using Parker cells. The use of the flotation process was continued throughout 1928. An article,⁵ comparing the two processes in detail, was published in August.

Eureka district.—Six lode mines in the Eureka district produced 6,006 tons of ore in 1928, yielding \$46,506 in gold, 30,530 ounces of silver, 26,168 pounds of copper, and 932,090 pounds of lead, valued in all at \$122,195, or \$20.35 in metals a ton. All the ore was of smelting grade and the entire output was shipped to smelters in

⁵Greenan, J. O., and Bagley, E. M., Why Flotation Displaced Cyanidation at Cortez: Eng. and Min. Jour., vol. 126, Aug. 6, 1928, pp. 173-176.

Utah. The Richmond-Eureka property, controlled by the United States Smelting, Refining & Mining Co., was operated by lessees who produced the greater part of the output of the district. All the mining and milling operations at the Holly Consolidated Mines Co. were discontinued in April, 1927, and the activity of its affiliated companies during 1928 was confined to development work on mining claims. During this development one car of oxidized lead ore was shipped. One lot of silver ore containing gold was shipped from the Bear claim and small lots of lead ore were shipped from the Hamburg and Pearl claims.

HUMBOLDT COUNTY

Amos district (Slumbering Hills).—At the Alabama property, 47 miles from Winnemucca, ore was treated by amalgamation in a 5-stamp mill, which was operated in 1927 and 1928, and gold bullion was produced. From Doc's mine some ore was treated at the Davey Town custom amalgamation plant.

Black Rock district.—During 1927 and 1928 the Grubstake property was operated and small shipments of ore were made from surface cuts in prospecting for high-grade silver chloride. Shipments were made by way of Sulphur, on the Western Pacific Railroad.

Gold Run district (Adelaide).—Two small lots of lead-zinc ore were shipped from the Gold Run district to Utah concentration plants. The ore was mined from the Great Republic property, operated by lessees, and from other prospects in the district.

Iron Point district.—The Silver Coin property near Golconda in the Iron Point district produced silver ore in 1927. The property did not report production in 1928.

National district.—Development work was started in 1927 at the property of the National Consolidated Mines Co., 70 miles north of Winnemucca, and its 50-ton flotation mill was operated part of the time to the end of 1928. During these operations some silver concentrate was produced, making the National mine a silver producer instead of a gold producer, for which it was once famous. From the Buckskin-National mine three car lots of siliceous gold-silver ore were hauled 65 miles to Winnemucca and shipped to the Mason Valley smelter.

Preble district.—Old tailings from the Dolomite property in the Preble district were treated experimentally by cyanidation in 1927, but operations were not continued in 1928.

Sherman district.—Although the Big Four property in the Sherman district produced a car of rich gold ore in 1927, which was shipped to a smelter, operations consisted only of development work in 1928. The Basque Mining & Milling Co. operated the property, which is 23 miles north of Winnemucca, in the Bloody Run Range. The mine is opened by two tunnels, 635 and 640 feet long, and by 352 feet of crosscuts.

Ten Mile district.—In 1928 gold bullion was marketed from amalgamation operations at the Myers Extension property and other prospects in the Ten Mile district. Although the output was small, indications were encouraging, and prospecting was continued.

LANDER COUNTY

Battle Mountain district.—In 1928 bullion from six placers and 15,608 tons of ore from 15 lode mines in the Battle Mountain district yielded \$20,091 in gold, 32,482 ounces of silver, 3,075,242 pounds of copper, and 138,223 pounds of lead, valued in all at \$489,945. The ore had an average value of \$30.99 in metals a ton. The placer bullion contained \$6,282 in gold and 51 ounces of silver, valued together at \$6,312. With the exception of 226 tons of ore treated at gold and silver mills and 3,000 tons of ore concentrated, the output was of smelting grade, chiefly copper ore. Altogether 12,382 tons of ore was shipped direct to a smelter and yielded 221.55 ounces of gold, 16,508 ounces of silver, 3,072,294 pounds of copper, and 116,121 pounds of lead. In 1927 bullion from six placers and 5,738 tons of ore from 13 lode mines yielded \$12,876 in gold, 6,017 ounces of silver, 1,312,871 pounds of copper, 47,140 pounds of lead, and 20,510 pounds of zinc, valued in all at \$192,556. The ore had an average value of \$32.75 in metals a ton. The placer bullion contained \$4,633 in gold and 28 ounces of silver, valued together at \$4,649. In 1928 the Copper Canyon property, including the Sweet Marie, Widow, and Henrietta claims, showed a marked increase in its ore output, all of which was made by lessees.

For the past two years the Copper Queen mine has been an important producer of copper ore mined by lessees. The Buffalo Valley Mines Co. continued to treat its ore experimentally by cyanidation. Interesting experimental work was done at the Buckingham mine by the Buckingham Mina Consolidated Mines Co. Table concentration was discarded for flotation in 1927 and 1,500 feet of development work was done in the mine. An article⁶ written early in 1927 described the development of this property and stated that there was a large quantity of ore blocked out containing chiefly gold and silver. The mine is opened by a vertical shaft 550 feet deep, by 7,000 feet of drifts, and by a tunnel 200 feet long. About 2,000 feet of this development work was completed in 1928. Several small lots of siliceous gold ore were mined from the Eldorado claims and oxidized lead ore was produced from the Snow Storm property. The Marion mine of the Nevada Mining Co. was operated by lessees who shipped two cars of lead ore in 1928. Placer output for the past two years was chiefly from the Dahl, Homestake, and other claims in Copper Canyon, 20 miles southwest of the town of Battle Mountain. Dry placer ground is worked by drifting on bed rock to a depth of 35 to 50 feet.

Bullion district.—Four lode mines in the Bullion district produced 105 tons of ore in 1928, compared with 640 tons in 1927. Ore produced in 1928 was all shipped to smelters and yielded \$7,118 in gold, 1,225 ounces of silver, and 8,024 pounds of lead, valued in all at \$8,300, or \$79.05 in metals a ton. In 1927 considerable ore of milling grade was treated at the 100-ton mill of the Tenabo Consolidated Mines Co. These operations were not continued in 1928, and only two car lots of siliceous gold ore, averaging 3.8 ounces of gold to the ton, were shipped direct to a smelter from the 45-foot level of the company's "Gold Quartz" claim. The main development of the property is on the 300-foot level. At the Silver Gem mine some development work resulted in the shipment of a small lot of lead ore to a smelter.

⁶ Arizona Mining Journal, Jan. 1, 1927.

Gold Basin district.—The Gold Dollar group, known as the Buzanes property, was under development and a 10-stamp Straub mill was operated experimentally 60 days, treating 240 tons of ore from the mine and old dumps. The average value of the material treated was \$9.10 in gold and silver. The property is opened by 600 feet of drifts and tunnels and has a vertical shaft 200 feet deep. The mine is 44 miles south of Austin, the shipping point.

Hilltop district.—Siliceous silver ore was shipped to the Mason Valley smelter from the Gray Eagle mine in 1928. No operations were reported from the Hilltop district in 1927.

Lewis district.—The Betty O'Neal mine, 15 miles south of Battle Mountain, was worked on a 2-shift basis throughout the past two years and the mill, a 200-ton flotation plant, was operated eight hours a day. Concentrates, which contain sufficient lead to be classified as a lead product, were unusually rich in silver; in fact, the mine was the largest producer of silver in Nevada in 1927 and the third largest producer in 1928. No annual report to stockholders for 1928 was received, but according to the report to stockholders for 1927 the mine produced 26,314 tons of ore, all of which was milled. From this milling ore 1,679 tons of concentrate were recovered, which contained 781,450 ounces of silver, an average of 465 ounces to the ton of concentrate. The concentrate also contained gold, copper, and lead, and the company received net smelter returns of \$409,900, after deduction of charges for freight and treatment. The average value of the ore milled in terms of net smelter returns was \$15.58 a ton. The ratio of concentration was 15.68 tons of ore to 1 ton of concentrate. The mining and development cost was \$5.88 a ton, milling \$2.01, and indirect charges \$2.46, or a total of \$10.35. The dividends paid to stockholders in 1927 amounted to \$93,012. Ore reserves were not published, but the silver content of the mill heads has increased from 14.10 ounces to the ton in 1922 to 30.3 ounces in 1927. The total silver content of the concentrate from 1922 to 1927 was 3,223,065 ounces. The flotation mill continues to make the remarkable silver extraction of 98 per cent. The Estella vein, which has produced all of the ore milled since operation was begun six years ago, is opened by a series of tunnel levels, the lowest of which is No. 4.

Reese River district.—No output was reported from the Reese River district in 1928, but four lode mines and one placer in 1927 produced 42 tons of ore and a total value in metals of \$4,553. Two lots of silver ore were shipped by lessees from the Hardy and Watt properties, and one lot of silver-lead ore was shipped from the Roosevelt claim, which is north of Main Street in Austin.

Skookum district.—The Skookum district was not a producer in 1928. In 1927 several cars of rich silver ore were shipped from the Gweenah claim, 10 miles west of Austin.

LINCOLN COUNTY

Caliente (Chief) district.—The Lucky Hobo claim of the Advance Mining Co. produced siliceous gold ore and a small lot of lead ore in 1928. Both shipments were sent to a smelter in Utah.

Comet district.—In 1928 one car of oxidized lead ore containing silver was produced by lessees from the Mountain Lion claim in the Comet district. Lessees also shipped oxidized lead ore in 1927.

Ferguson (Delamar) district.—Lessees on the April Fool mine, a part of the old Delamar property, shipped a car of ore containing gold and silver, and also a small quantity of bullion in 1928; ore and bullion were shipped in 1927 also.

Groom district.—Development was continued in 1928 at the Groom mine, opened by more than 3,400 feet of work, and several cars of silver-lead ore were hauled 103 miles to Las Vegas, on the Union Pacific Railroad. Shipments of lead ore were made in 1927 also.

Jack Rabbit district.—The Bristol Silver Mines Co., in the Jack Rabbit district, was the largest producer of lead in Nevada in 1927 and 1928. In 1928 the company reported the shipment of 41,304 tons of oxidized lead-copper ore containing 551.46 ounces of gold, 496,032 ounces of silver, 2,382,307 pounds of copper, and 5,075,748 pounds of lead. This mine is opened by an inclined shaft 1,200 feet deep. One lot of lead ore was shipped from the New Bristol property. The Black Metals mine has been idle the past two years.

Pahranagat district (Hiko).—One lot of silver ore containing a little copper was produced from the Rosie mine, 55 miles from Caliente. The ore was taken out in developing the property. Silver ore was also produced from the Silver Dollar group.

Pioche district.—Five producers of ore in the Pioche district reported the output of 26,834 tons in 1928, yielding \$10,542 in gold, 165,934 ounces of silver, 73,055 pounds of copper, 2,333,170 pounds of lead, and 5,370,180 pounds of zinc, valued in all at \$581,039, or \$21.65 in metals a ton. All of the output, with the exception of 32 tons shipped direct to a smelter, was of milling grade. Most of the district output was that of the Panaca group of the Combined Metals Reduction Co., which ships its ore to its mill at Bauer, Utah, for separation into lead and zinc concentrate. The mine is extensively developed by a 1,400-foot vertical shaft and by 15,000 feet of drifts. In 1927 the company completed a new hoisting plant, housed in fireproof steel buildings, and a steel headframe to replace the temporary structure erected after the fire in September, 1926. Ore and concentrates were also shipped from four other properties—the Chisholm, Pioche Mines, and two prospects. No ore was shipped in 1928 from the Virginia Louise mine, leased to the Prince Consolidated Mining Co., and only a few hundred tons were shipped in 1927, compared with its output of 6,000 tons in 1926.

Tem Piute district.—Lessees operated the Tem Piute mine, 80 miles southwest of Caliente, in 1928, and 100 tons of siliceous silver ore were shipped to Utah for smelting. This quantity is only half that produced and shipped in 1927.

LYON COUNTY

Ramsey district.—The operator of the Ramsey Comstock property in 1926 shipped considerable ore from Appian, on the Southern Pacific Railroad. This property was practically idle in 1927, but two cars of gold ore were shipped to the Mason Valley smelter. The operations for 1928 were not reported.

Silver City district (Palmyra, Dayton, Como).—The 13 lode mines in the Silver City district produced 68,826 tons of ore and old tailings in 1928, yielding \$43,527 in gold, 55,202 ounces of silver, 17,118 pounds of copper, and 1,244 pounds of lead, valued in all at \$78,357,

or \$1.14 in metals a ton. The district output consisted of 46 tons of crude ore shipped to a smelter; 2,830 tons of ore and 950 tons of old tailings treated in gold and silver mills; and 6,500 tons of old tailings concentrated, from which was recovered 805 tons of concentrate. A large part of the gold and silver yield resulted from the flotation of old Douglas tailings by the Dayton Syndicate (Inc.), and several hundred tons of calcined concentrate rich in silver was shipped to various smelting plants.

As these old tailings contain considerable mercury that was used in early milling operations on the Comstock Lode, the flotation concentrate was dried and retorted for the recovery of mercury; 299 flasks were marketed in 1928, compared with 200 flasks in 1927. Two thousand tons of mine backs taken from old workings in the Comstock-Red Jacket property yielded gold and silver bullion; this was recovered by amalgamation and cyanidation. Lessees worked the Oest and Buckeye mines and shipped several hundred tons of gold ore to the McTigue custom mill, where it was treated by amalgamation. This mill was recently purchased by the Red Jacket Co.; it now has 15 stamps and table concentrators. The remainder of the district output resulted from ore and old tailings treated at the Trimble-Hamilton and Donovan cyanide plants near Silver City and from ore taken from various other properties by lessees. The Gordon mine, 1 mile south of Silver City, according to its owner, has produced considerable gold and silver ore of \$12 to \$17 grade; in 1928 the property was under development by the Silver Pick Consolidated Mining Co. The Pony Meadows property in the east end of the Como region, 15 miles south of Dayton, was also under development.

Talapoosa district.—A lessee working in the Talapoosa mine shipped gold and silver ore which amounted to 161 tons in 1928 and to more than 500 tons in 1927. Shipments were made by way of Appian, on the Southern Pacific Railroad.

Yerington district.—Two lode mines in the Yerington district produced copper ore in 1928. The producing properties were operated by the Mason Valley Mines Co. and the Empire Nevada Copper Mining & Smelting Co. Six lode mines in 1927 produced 378,921 tons of copper ore, which was milled and reduced to 35,412 tons of copper concentrate, 13,884 tons of first-class copper ore, and 19 tons of siliceous silver ore treated at a smelter. The Mason Valley Mines Co., the largest producer in the district, worked its properties near Mason throughout 1927 and 1928; its 1,000-ton flotation plant was worked continuously on copper ore. Concentrate and crude ore were smelted at the company's plant at Thompson; this plant also treated custom material from Nevada and California. It is equipped with two blast furnaces, but only one was active. According to the annual printed report of the Mason Valley Mines Co., 132,518 tons of ore was smelted in 1928. Of the ore smelted 80,798 tons was company and lease ore and 51,720 tons was from outside sources. The furnaces produced from these ores 8,772 tons of blister copper containing 16,831 ounces of gold, 251,088 ounces of silver, and 17,334,240 pounds of copper. The flotation mill, near the mines of the company, operated at full capacity, treating 475,848 tons containing 1.3 per cent of copper at an average rate of 1,300 tons a day and a cost of 59 cents a ton. The mill recovery averaged 91.27 per cent of the sulphide copper, which contained 86.33 per cent of

the total copper. From this ore 41,556 tons of concentrate was recovered, averaging 0.31 ounces of silver and 12.92 per cent of copper.

Mining operations during the year were continuous, and the Mason Valley group of mines produced 130,307 tons of mill ore averaging 1.76 per cent of copper. The cost of delivering this ore to the mill was \$1.02 a ton. In addition, 6,849 tons of carbonate of copper ore was shipped to a smelter.

From the Bluestone group 345,541 tons of mill ore averaging 1.13 per cent of copper was delivered to the crushing plant for 48 cents a ton. Certain areas of the mine were stripped of overburden amounting to 26,047 tons, of which 12,310 tons, largely limestone averaging 1.57 per cent of copper, was shipped to the smelter for fluxing.

MINERAL COUNTY

Aurora district.—A small lot of siliceous gold ore was shipped from a prospect in the Aurora district.

Bell district (Mina).—A lessee shipped siliceous gold ore and some old tailings from the Olympic property to the Mason Valley smelter. Lead ore was produced from the New Era claim. The Bi-Metallic property of the Simon Silver-Lead Mines (Inc.) was under development and 1,637 feet of crosscuts and some drifting were reported but no new ore was found. Occasional patchy ore showings were exposed on the 800-foot level. From 1922 to 1927 the mine was a large producer of both lead and zinc, but market conditions in 1927 prevented further work.

Garfield district.—The Mabel group of the West End Consolidated Mining Co. produced 360 tons of ore shipped by way of Mina to smelting plants in Utah. The ore varies in character, but most of it is valuable for its gold and silver. A small lot of rich silver ore, mined by lessees, was shipped from the Garfield property, which adjoins the Mabel group.

Hawthorne district (Pamlico).—Lessees working the Lucky Boy mine operated the concentration-flotation plant a short time during 1927 and 1928, and in each of those years a car of lead concentrate rich in silver was shipped to Utah for smelting. The ore from the mine dumps, some of which was sorted, proved too low grade in lead to be profitable. A little gold ore from the Gold Bug property was treated by amalgamation. One small lot of lead ore was shipped from the War Eagle claim.

Monte Cristo district.—Small lots of gold ore were shipped from the Last Hope claim and King group on the west side of the Monte Cristo Range in 1927. No production was reported in 1928.

Rand district.—In 1928 six lode mines in the Rand district produced 243 tons of ore yielding \$3,765 in gold, 2,465 ounces of silver, and 11,242 pounds of copper, valued in all at \$6,826, or \$28.09 in metals a ton. The Copper Mountain Mines Syndicate shipped copper sulphide ore from its property 18 miles from Nolan to the Mason Valley smelter. The Antelope, Nevada Rand, Gold Vein, Golden Pen, and Comoker mines were operated by their owners or lessees, who shipped gold and silver ore to Thompson. In 1927 five mines produced 455 tons of ore yielding gold, silver, copper, and lead, valued in all at \$12,586, or \$27.66 in metals a ton.

Regent district (Rawhide).—Of the four producers of gold and silver ore in the Regent district in 1928, the Happy Hooligan claim of the Truett group was the largest. This property has been under development since November, 1927, and, according to the owners, promises to develop into a large low-grade milling ore deposit.

Santa Fe district.—Five lode mines in the Santa Fe district produced 350 tons of ore yielding \$3,898 in gold, 1,809 ounces of silver, and 6,251 pounds of copper, valued in all at \$5,856, or \$16.73 in metals a ton. This output compares with 175 tons of ore produced in 1927 with a total value in metals of \$4,932, or \$28.18 a ton. Various properties, operated by lessees, produced ore in the Santa Fe district in 1928; the Desert View was the most important producer. As the Mason Valley smelter was active, lessees in the district were able to ship low-grade siliceous gold ore from several old producing mines.

Silver Star district (Marietta, Black Mountain, Gold Range, Douglas Camp).—In 1928 eight producers of ore from mines within the Silver Star district and adjoining territory reported an output of 538 tons, mostly of milling grade, compared with 236 tons in 1927. Only 78 tons of gold ore of shipping grade went to a smelter, and 460 tons yielded gold bullion by amalgamation and cyanidation. The principal producers of gold ore were the Giant Development Co., operating the Banner or Bounce mine, and the Kernick Divide Mining Co., operating the Gold Crow, Sarah, and Blue Ridge claims. The Nevada-Douglas Gold Mines (Inc.) operated its mine and mill, and early in 1928 recovered some gold bullion by cyanidation. Later in the year the company ceased operation on account of financial troubles.

Sodaville district (Pilot Mountains).—Copper ore from the Kismet and a small lot of siliceous gold ore from the White Rock claim represented the total output of the Sodaville district in 1928.

NYE COUNTY

Athens district.—The Warrior property, under development by lessees, is reached by way of Mina and is but 4 miles from the Simon-Lead mine in Mineral County. Operations in 1928 resulted in the shipment of 120 tons of ore containing 1.42 ounces of gold and 0.78 ounce of silver to the ton. Two car lots of ore were shipped in 1927.

Bellehelen district.—Several cars of ore were hauled from the Bellehelen district 45 miles to a custom plant treating ore by cyanidation at Tonopah. The chief producer in 1928 was the Clifford mine, which, with the Cedar and one other property operated by lessees, produced 168 tons of siliceous gold-silver ore from which was recovered \$7,478 in gold and 12,275 ounces of silver. In 1927 the Clifford Gold Mines Co. operated its 50-ton cyanide plant a short time. The ore output from this mine and six other properties operated by lessees amounted to 2,340 tons and yielded \$15,980 in gold and 23,951 ounces of silver, valued together at \$29,560, or \$12.63 in metals a ton.

Bullfrog district (Beatty).—The July group, which includes the old Bull Moose claims of the Gold Ace Mining Co. operating near Cararra, and the Pioneer property at Beatty were the only producers of ore in 1928 in the Bullfrog district. The output in 1927 from seven properties was 215 tons of ore, yielding \$1,696 in gold, 747 ounces of silver, 564 pounds of copper, and 5,105 pounds of lead,

valued in all at \$2,516, or \$11.70 in metals a ton. The Pioneer property was operated each year and considerable work was done in prospecting the ore deposits and reconditioning the old mill. A 50-ton plate amalgamation mill constructed in 1928 for treating Gold Ace ore was operated from November 15, with occasional interruptions. The bullion recovered had a fineness of 0.739 gold and 0.255 silver. Veins of quartz about 3 inches wide contain free gold in a bedded deposit of oxidized iron, largely limonite, which is said to be 8 to 10 feet between walls.

Eden Creek district (Gold Belt).—The Eden Creek district is 60 miles east of Tonopah, and the principal activity in 1928 was at the Southgold-Nevada Mines property. A small washing plant was used to test the surface material, which carries \$2 to \$6 a ton in gold and very little silver after screening. The property is opened to a depth of 220 feet by an inclined shaft.

Hannapah district.—During 1928 the World Exploration Co. of Nevada developed the Silver Leaf group, which produced some siliceous silver ore; the ore was shipped to a smelter.

Johnnie district.—The Johnnie mine and a 16-stamp amalgamation mill were operated in 1928.

Mammoth (Lodi or Quartz Mountain) district.—In 1928 the output of 180 tons of ore had a metal yield of \$5,326, or an average of \$29.59 in metals a ton. Shipments in 1927 had a total value of \$284,948 in gold, silver, copper, and lead, or an average of \$41.33 in metals a ton. Shipments of 180 tons of ore were made from three properties in the Mammoth district in 1928, compared with the same number of properties producing 6,895 tons of ore in 1927. The Illinois or Lodi mine and San Rafael property were the principal producers each year. Early in 1928 the San Rafael Consolidated Mining Co. sold most of its property to the Quartz Mountain Mines & Milling Co.

Manhattan district.—Nine placers and 15 lode mines in the Manhattan district produced 7,339 tons of ore and old tailings in 1928, \$158,402 in gold, and 1,229 ounces of silver, valued together at \$159,121. The ore and old tailings had an average value of \$20.74 in metals a ton. Of the total ore and old tailings 5,767 tons was ore of smelting grade, 1,072 tons was ore treated in gold and silver mills, and 500 tons was old tailings (from amalgamation) treated by cyanidation. In 1927 the district output from 8 placers and 11 lode mines was 6,253 tons of ore, \$185,750 in gold, and 2,122 ounces of silver, valued together at \$186,953. The ore had an average value of \$29.42 in metals a ton. The placer output in 1928 consisted of \$6,814 in gold and 181 ounces of silver, valued together at \$6,920, compared with \$2,944 in gold and 61 ounces of silver, valued together at \$2,979, in 1927. Most of the gold was recovered from the property of the White Caps Gold Mining Co. The company was the eighth largest producer of gold in Nevada in 1928. All of its ore shipments were made to the Mason Valley smelter at Thompson. The Jumbo property, worked by a partnership, was developed throughout each year, and several hundred tons of gold ore was treated by amalgamation. Ore containing gold and silver was shipped from the Blaker-Sloan mine of the Keystone Divide Mining Co. for treatment by cyanidation at Tonopah. Some of the ore was treated by amalgamation at the War Eagle mill at Manhattan. The placer output for the past two years was recovered in small lots from the Arizona,

African, Bonanza, Double Jack, Gold Nugget, Prince, Donald Associated Placers, and Humphrey claims in Manhattan Gulch. Some closely sorted free gold ore treated in a hand mortar was produced from the Mammoth Contact claim.

Reveille district.—Only the mine dump of the Halloween mine was worked over and rich silver ore screenings with several lots of lead ore were shipped to a smelter.

Round Mountain district.—One placer and three lode mines in the Round Mountain district produced 12,293 tons of ore in 1928, \$98,567 in gold, and 4,051 ounces of silver, valued together at \$100,937. The ore had an average value of \$8.21 in metals a ton. The value of the district output showed an increase from \$84,930 in 1927. As in the past, most of the output of the district was from the Round Mountain Mines Co., which operates both placer and lode mines 65 miles northeast of Tonopah. The lode mine is equipped with a 20-stamp mill, 2 Huntingtons, 2 tube mills, and a Hardinge mill, and the placer property has extensive hydraulic equipment. No dividends were paid in 1927. Two small lots of siliceous silver ore from the Silver Point and Silver Shield claims were hauled to Tonopah for shipment to the smelter. In 1927 one small lot of silver concentrate was shipped from the Kanrohat mine, worked by the Elsa Mining Co. The company did not operate in 1928. A consolidation of all of the mines at Round Mountain is under way and plans are ready to mill not only the lode ore but the surface material of the placer claims as well.

San Antone district (Royston).—In the Hudson tunnel, opened for the development of the Best Chance and Golden Eagle claims, a small quantity of ore was mined from a depth of 165 feet from the surface. The ore contained 25 per cent of lead, 120 ounces of silver, and \$3 in gold to the ton.

Tonopah district.—Nine lode mines on the Nye County side and two on the Esmeralda County side of the Tonopah district produced 103,109 tons of ore, yielding \$415,035 in gold and 1,900,315 ounces of silver, valued together at \$1,526,719, or \$14.81 in metals a ton. This output consisted of 1,766 tons of ore of smelting grade and 101,343 tons of ore treated by cyanidation. The value of the output from this region decreased from \$1,689,127 in 1927. The total output of the district compared with that of 1927 is shown in the following table:

Mine production of gold, silver, copper, and lead in the Tonopah district, Esmeralda and Nye Counties, Nev., 1927 and 1928, and total, 1904-1928

Year	Mines producing	Ore	Gold	Silver	Copper	Lead	Total value
		<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	
1927	15	125,790	\$460,044	2,167,694			\$1,689,127
1928	11	103,109	415,035	1,900,315			1,526,719
Total, 1904-1928		7,993,050	34,549,754	157,740,967	12,175	214,523	135,516,262

The Tonopah Belmont Development Co. continued to ship ore to the custom cyanide plant at Millers. The bullion output was somewhat less than in 1927. The development of the mine consisted of

2,365 feet of drifts, crosscuts, and raises. The 500-ton 60-stamp cyanidation and concentration plant at Tonopah was sold to the U. S. Machinery & Steel Co. and was dismantled in 1927. No dividends were distributed in 1927 or 1928, but the company has paid \$10,943,-063 in the past. According to the printed report of the company, the mine, operated continuously during 1928, produced 18,797 dry tons of ore, compared with 20,897 tons in 1927. The low price of silver necessitated close sorting of all rock broken underground in order to produce an ore of shipping grade. The total ore and waste broken in the mine in 1928 amounted to 41,200 tons. Of this, 22,403 tons was waste from development and sorted from ore broken in the mine in stopes. The net earnings from the Belmont mine during 1928 were \$15,170.83, or 80.7 cents a dry ton of ore shipped, as compared with \$38,226.16, or \$1.898 a ton shipped in 1927. All ores produced were shipped to the milling plant of the Tonopah Mining Co. at Millers.

The output of gold and silver from the property of the Tonopah Mining Co. of Nevada was greater than in 1927 and the company was the second largest producer of silver in Nevada in 1928. Dividends of \$150,000 were paid, corresponding to the amount paid during 1927, making a total to date of \$16,725,000. All the earnings, however, were not from Nevada, as the company operated mining property in other States and in Canada and Mexico. The 400-ton cyanidation plant at Millers was operated continuously on company ore and custom material and treated 71,561 dry tons of ore which yielded, according to the company's annual report, 18,315 ounces of gold and 1,574,336 ounces of silver. Of the ore milled 28,898 tons was from the mine at Tonopah and 42,663 tons was custom ore.

The Tonopah Extension Mining Co. operated its 500-ton plant at Tonopah and produced a decreased quantity of silver ore for treatment by cyanidation. Some of the ore was shipped to the Mason Valley smelter. The company owns property in both Nye and Esmeralda Counties, and the output for 1928 came entirely from the western part of the district in Esmeralda County, where the company has done considerable development. The property is opened by six vertical shafts 2,375 feet in depth and has 42 miles of drifts and crosscuts. The silver occurs chiefly as argentite, but the ore also contains chalcopyrite, pyrite, and sphalerite. At the mill the ore is crushed to one-quarter mesh by sixty 1,150-pound stamps; it is reground in tube mills, thickened in five Dorr thickeners, agitated 60 hours in 15 Trent agitators, and filtered in a Butters filter. The bullion from the precipitates is shipped to California for refining. No dividends were distributed in 1927 or 1928, although the company paid \$3,927,221 in dividends from 1905 to 1925.

The West End property on the Nye County side of the line was worked continuously, but the mill, a 265-ton cyanidation plant, was closed October 15, 1927. Thereafter the ore was treated at the cyanide plant of the Tonopah Mining Co. at Millers. The company reported production of 9,834 tons of milling ore, containing 2,949.20 ounces of gold and 268,723 ounces of silver, having a gross value of \$215,373. The West End Consolidated Mining Co. continued to work the Mabel mine in Mineral County and is interested in the Tonopah "76" and West End Extension properties in Esmeralda County. The North Star mine of the Tonopah North Star Tunnel

& Development Co. was worked under lease in 1927 and 1928 and several hundred tons of silver ore was shipped to a local custom cyanidation plant. The Rescue Eula mine was worked under lease in 1927 and several cars of silver ore were milled; the mine was not operated in 1928, and all activities seem to be directed on property in California. A lessee on the Montana-Tonopah property produced several cars of silver ore for milling in 1927 and 1928, and lessees cleaned up considerable material from the Belmont mill and sorted ore from mine dumps in the vicinity of Tonopah. The Tonopah "76" property in Esmeralda County was operated under lease by the West End Consolidated Mining Co. until March, 1928. In 1927 more than 2,800 tons of ore was shipped for treatment to the West End mill at Tonopah, but in 1928 only 400 tons was produced and treated at the Millers plant of the Tonopah Mining Co. The West End Extension property was operated by the West End Consolidated Mining Co. in 1927, and nearly 5,000 tons of silver ore was mined for treatment by cyanidation. To the close of 1927 development was carried on from the 800-foot level of the Ohio shaft of the West End Consolidated Mining Co.

Tybo district (Hot Creek).—The Treadwell-Yukon Co. (Ltd.) started operations early in 1926 and after building a power line and equipping its property raised a new shaft through from the 710-foot level to the surface. The total work done in this connection was 3,514 feet, including 823 feet of shaft work. The annual printed report of the company for 1928 contains the following paragraphs:

* * * The 560 ft. level was extended 67 ft.; and of this distance, 610 ft. was on the vein which averaged 5.1 ft. wide, with an assay of 0.02 oz. gold, 11.72 oz. silver, 8.75 per cent lead, and 6.0 per cent zinc.

The average assay of all car samples taken from the mine up to Dec. 31, 1928, was 0.018 oz. gold, 10.05 oz. silver, 7.26 per cent lead, and 5.35 per cent zinc. The average of all face samples was 0.02 oz. gold, 13.39 oz. silver, 9.22 per cent lead, and 6.65 per cent zinc. The average of all samples combined is 0.02 oz. gold, 11.72 oz. silver, 8.74 per cent lead, and 6.00 per cent zinc. * * *

Work was started on the mill and it is expected that this will be in operation in May, 1929. The mill will contain the following equipment: one 18" x 30" Jaw Crusher (Allis Chalmers), one 3' x 8' Link-Belt Vibrating Screen, one 4 Foot Symons Cone Crusher, one Merrick Weightometer, two 8' x 48" Hardinge Ball Mills, two 6' x 25' Dorr Classifiers, four 4" Wilfley Sand Pumps, five 2" Wilfley Concentrate and Middling Pumps, two 16 Cell-18" Sub-A M. S. Flotation Machines, three 24' x 8' Hardinge Thickeners, and two 5' 4" x 10' Oliver Filters. It is expected that the mill will have a capacity of 250 tons per day.

This was the property that the Louisiana Consolidated Mining Co. attempted to rejuvenate, and a 75-ton concentrator was built in 1917 and operated in 1918. In 1919 a flotation plant and smelter were completed and operated in 1920 without success.

Union district (Ione).—At the Alexander property, which has not been worked since the early eighties, preparations were made to unwater the shaft. In the meantime ore sorted from the old dumps, containing some galena and sphalerite, was treated experimentally by flotation. Mill tailings from the Union Canyon mill and ore from the several small prospects in the Union district were shipped to Mason Valley smelter for treatment.

Wahomie district.—One company, the Reorganized Booth Mines organization, continued work throughout 1928 in the Wahomie silver-gold district, 30 miles east of Beatty. Considerable excitement

was caused last February when ore was discovered in the district. A shaft sunk 300 feet opened up a vein with small pockets of ore. About \$21,000 has been spent on development work.⁷

Willow Creek district.—Claims near Nyala produced gold ore, some of which was shipped for smelting and a little was treated by amalgamation. A new 25-ton amalgamation mill constructed for the Nevada-California Mining Co. in 1927 was not active in 1928.

ORMSBY COUNTY

Voltaire district.—The Voltaire claim produced ore in 1927 but not in 1928. Copper ore was shipped to the Mason Valley smelter from the property of the Premier Mines Corporation, operating 3 miles west of Carson City. New ore found during 1928 encouraged the owners to start construction of a flotation plant, which is expected to treat 100 tons of ore daily, beginning in 1929. About 3,000 feet of development work has been done in the mine, and the ore is said to carry 2 to 6 per cent of copper and a little silver and gold.

PERSHING COUNTY

Antelope district.—The Nevada Superior mine was operated several months under lease during the past two years, and two cars of silver-lead ore were shipped to Utah for smelting. The Antelope property north of Majuba Peak produced silver ore containing a little copper of shipping grade. Both properties are about 25 miles from Jumbo on the Western Pacific Railroad.

Arabia district (Oreana).—None of the lode mines in the Arabia district were producers of ore in 1928, but five operators reported a production of 200 tons of ore in 1927, yielding \$396 in gold, 5,619 ounces of silver, 210 pounds of copper, and 79,334 pounds of lead, valued in all at \$8,607, or \$43.04 in metals a ton. The Jersey-Montezuma property of the Pershing County Mines Co. was not worked actively on company account, but several cars of oxidized lead ore were shipped by lessees to smelters in Utah. Oxidized lead ore containing 9 to 18 per cent of antimony was also shipped from the Electric and Lead Fraction properties.

Jersey Valley district.—During 1927 and 1928 the Rex group of claims in the Jersey Valley district produced silver-lead ore which was shipped to a smelter in Utah. A large quantity of ore is said to be blocked out in this property; the property, however, is being developed only in a small way.

Kennedy district.—The Fourth of July claims in the Kennedy district, 60 miles south of Winnemucca, produced in 1928 a small lot of ore containing considerable silver and gold, which was shipped for smelting.

Rochester district.—Three lode mines and a placer claim in the Rochester district produced 30,627 tons of ore in 1928, including some sweepings from a tailing pond, yielding \$39,448 in gold, 240,346 ounces of silver, and a little copper and lead, valued in all at \$180,180. The ore averaged \$5.87 in metals a ton. Most of the ore was treated by cyanidation in the 150-ton cyanide plant of the Rochester Silver Corporation, operated by lessees, who did most of

⁷ Engineering and Mining Journal, Dec. 8, 1928, p. 918.

the mining and milling. The district output in 1927 was 23,939 tons of ore, valued at \$131,265, or \$5.48 in metals a ton. The Frances and Monumental properties were sold in July, 1928, to the Rochester Canyon Mining & Milling Co.; they produced up to that time about 500 tons of ore, recovering the bullion in a 10-stamp amalgamation mill. The output included some sweepings from a tailing pond, which were shipped to a smelter in California. During 1928 the Rochester Unity Mines Co. was reorganized to include the Raven, Daisy, and Rochester Gold Mines Co., comprising 16 claims adjoining the Great Western or Lincoln Hill property which it also controls. These properties were among the first locations on Lincoln Hill, following the discovery in 1912 on Nenzel Hill, two miles up the canyon.

Seven Troughs district.—The long drainage tunnel of the Seven Troughs Gold Mine has been advanced over 7,000 feet and is said to be within 700 feet of its objective, the Coalition vein. The Coalition mine suspended work several years ago in rich ore because of a constantly increasing flow of water. A small quantity of gold bullion was shipped by lessees of the Seven Troughs district in 1927 and 1928.

Sierra district (Sunshine, Chafey, Dun Glen).—The Black Hole & Mayflower properties were worked by the White Bear Syndicate during 1927 and 1928 and produced gold ore, which was treated in a small mill by amalgamation. A shipment of siliceous ore was made to the Mason Valley smelter.

STOREY COUNTY

Comstock district.—The entire production of Storey County in 1927 and 1928 was that of the Comstock district. Nineteen producers reported 76,441 tons of ore and old tailings in 1928, compared with 20 producers reporting 81,827 tons of ore and tailings in 1927. The district output in 1928 was \$180,442 in gold, 37,679 ounces of silver, 5,709 pounds of copper, and a little lead, valued in all at \$203,316, or \$2.66 in metals a ton. With the exception of 874 tons of first-class smelting ore and 8,040 tons of old tailings (most of which were reconcentrated), the bulk was low-grade milling ore (67,527 tons) treated chiefly by cyanidation. Bullion shipped from the district in 1928 contained 7,907.21 ounces of gold and 11,179 ounces of silver. The tailings produced 114 tons of concentrate, containing gold, silver, and copper. In 1927 the district output was \$235,690 in gold, 62,051 ounces of silver, and 1,100 pounds of copper, valued in all at \$271,017, or \$3.31 in metals a ton.

The Flowery Mines Co. was the largest producer of ore treated by cyanidation during 1928 and continued to work the Lady Bryan and Berry properties. More than 64,000 tons of low-grade gold ore was treated, and bullion valued at more than \$136,000 was sold, chiefly to the United States assay office in Carson City, Nev., and to the mint at San Francisco. The property is 4 miles from Virginia City and was worked by the glory-hole method. Up to 1928 it had paid \$20,000 in dividends, but none were distributed during the year 1928. The successful mining and milling of such low-grade ore is unusually interesting, and the work was reviewed in a recent article.⁸ Old tailing from the Butters dump was treated in a 150-ton flotation

⁸ Carpenter, J. A., The Flowery Mine and Mill at Virginia City, Nev.: Eng. and Min. Jour., vol. 125, Apr. 28, 1929, pp. 690-693.

plant, and several lots of concentrate containing gold and silver were shipped to various smelters during 1927 and 1928. Ore from the Silver Hill mine was treated by amalgamation at a custom plant in Silver City. Other properties producing ore were the Comstock Phoenix, Comstock Silver, Hard Luck, Justice, Martha, Midas, and United Comstock.

The Comstock Tunnel & Drainage Co. shipped a small lot of ore to the Mason Valley smelter. This company through its subsidiary, the Sutro Tunnel Coalition (Inc.), purchased in June, 1928, all of the mines and mining claims, patented and unpatented, and real estate of the Comstock Co. This property included 23 of the mines on the Comstock Lode and all of the adjoining and outlying unpatented claims. Large quantities of ore of milling grade have already been opened. Under this one management now are many of the most important mines and mining properties on the Comstock Lode, including the Gould & Curry, Best & Belcher, Andes, Savage, Hale & Norcross, Chollar, Potosi, Bullion, Exchequer, Alpha, Imperial, Confidence, Challenge, Yellow Jacket, Crown Point, Belcher, Kentucky, Overman, Caledonia, New York, Alta, and Lady Washington. Of the above list of mines nearly all were formerly operated by the Comstock Merger Mines, from which company were acquired 56 additional mining claims. These mines are expected to be operated from the Sutro Tunnel; its north and south lateral branches, which are about $7\frac{1}{2}$ miles in length, are equipped with railroad tracks, electric traction, and other facilities for development.

WASHOE COUNTY

Leadville district.—No production was reported in 1928, but four lode mines in the Leadville district in 1927 produced 144 tons of ore, yielding \$2,575 in gold, 2,265 ounces of silver, 11,269 pounds of lead, and 1,191 pounds of zinc, valued in all at \$4,645, or \$32.26 in metals a ton. The output consisted of 45 tons of first-class lead ore, 95 tons of ore treated in gold and silver mills, and a small lot (4 tons) of lead-zinc ore milled as a test. With the exception of small lots of ore taken out by lessees, the Leadville property near Gerlach was not worked. Some free gold ore from the Reeder claim on Donnelly Mountain, northeast of Gerlach, was treated by amalgamation.

Peavine district.—The Gold Bond and Armistice claims each produced small lots of copper ore, which were shipped to the Mason Valley smelter.

White Horse district.—Six individual operators and lessees contributed to the small output of the White Horse district in 1928. The properties from which production was reported were the Renegade, Green Hill, Springfield Nevada, and Texas. Most of the ore was treated in the Effrick custom mill, equipped for amalgamation.

WHITE PINE COUNTY

Aurum or Silver Mountain district (Schellbourne).—The American Standard Mining Co. did some development on claims in the Aurum district and produced a small lot of silver ore, which was shipped to a smelter in Utah.

Cherry Creek district (Egan Canyon).—No ore was produced in 1928, but some old tailing, containing gold, silver, and lead, from old mill dumps in the Cherry Creek district, was shipped during 1927 and

1928 to a smelter in Utah. The Star mine, under lease in 1928, is expected to again become an important producer of ore under a new organization.

Duck Creek district.—In 1928 the total output of the Duck Creek district consisted of 135 tons of lead ore, valued at \$8,638, from the Carbonate Lead, Brotherhood, Ely Gibraltar, and McGill properties; the ore was shipped to smelters in Utah.

Granite district (Steptoe).—At the Cuba mine in the Granite district some high-grade lead ore and concentrate from hand jigs were shipped in 1928.

Osceola district.—A 10-stamp Straub mill, equipped for amalgamation and treating 8 tons of ore a day, was operated on the Lassie Jean mine of the Nickelson Mining & Milling Co., producing gold bullion. The property is opened by an inclined shaft sunk 130 feet on a vein dipping about 45°. This property is 42 miles from the nearest railroad station at East Ely. The placer output of gold and silver came from the Hard Pickings and Osceola Fraction claims. The Osceola Fraction, on the west side of Mount Wheeler, was worked by drifting and dry washing or by sluicing when there was enough water. The method of reaching the gravel is by shaft sunk 30 or 40 feet to bed-rock. Hoisting of the gravel is by gasoline engine and removing the waste rock by a combination of blower and riffles. The material caught in the riffles is panned.

Piermont district.—In 1928 no production was reported from the Piermont district. In 1927 the Piermont mine was being extensively developed by the Ely Calumet Co., which did 6,300 feet of work during that year. A small lot of highly siliceous silver ore was shipped to a smelter in Utah. The company, which is continuing its development work, is endeavoring to open enough ore to warrant erection of a treatment plant, as the property is 66 miles from Ely, on the Nevada Railroad.

Robinson district (Ely).—The output of gold, silver, and copper from ore reported by 11 producers, only three of which were of much importance, was decidedly greater in 1928 than in 1927. The output of lead was less, and no zinc was produced in 1928. In the output of gold and copper and in the total value of metal output the Robinson district has been the most important in the State for the past three years. The following table gives conclusive proof of the improvement in metal recovery from the low-grade porphyry gold ore of the Nevada Consolidated property, the largest producer in the district.

Mine production of gold, silver, copper, lead, and zinc in the Robinson district, White Pine County, Nev., 1927 and 1928, and total, 1904-1928

Year	Mines producing	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
		Short tons		Fine ounces	Pounds	Pounds	Pounds	
1927	12	4,488,009	\$988,090	175,708	1107,440,936	593,066	9,604	\$15,202,725
1928	11	5,730,471	1,442,902	233,944	141,969,162	406,188		22,046,877
Total, 1904-1928		63,770,467	11,502,231	1,996,829	1,428,730,297	4,880,629	6,070,025	251,655,213

¹ Includes copper saved from precipitates recovered from mine water.

The mines and reduction plants of the Nevada Consolidated Copper Co. were operated continuously during 1927 and 1928 and a record production of copper was made. The company milled more than 5,500,000 tons of low-grade copper ore in the 17,000-ton concentration-flotation plant at McGill and shipped concentrate and crude smelting ore to its copper smelting plant, which has a capacity of 2,000 tons a day. The mine has been worked by steam shovels, but preparations are nearly complete to take the ore out through a vertical shaft 700 feet deep. This 5-compartment shaft was concreted to its entire depth and the surface plant hoist installed. In the mill, which is being gradually changed to a complete flotation plant, Callow cells were replaced with Forrester cells, and in the smelter one 12-foot converter was added; with increased production, two reverberatory furnaces were operated a large part of the time. From the Nevada Consolidated property in Nevada 4,664,018 dry tons of ore from the shovel pits and underground workings was milled during the year. In addition to the foregoing, 941,942 dry tons of custom material was milled in 1928. The production of metal is not given separately by the company but is combined with that of the Ray Consolidated Copper Co. at Ray, Ariz., and the Chino mine at Santa Rita, N. Mex. The following paragraphs are from the company's annual report:

In 1928, the cost of steam shovel mining at the Nevada mine, exclusive of depreciation and all local, State, and Federal taxes, but including all other overhead expense of every kind, was 22.38 cents a ton, and the cost of stripping overburden was 57.10 cents a cubic yard. The increased cost as compared to former experience is due to a deficiency of cars and heavy locomotives to serve the deeper levels of the pit, from which most of the 1928 ore production was secured. Twenty-eight per cent of the 1928 ore production came from the ninth level and 57 per cent from the tenth or deepest level of the pit. Fifty new ore cars and sixty heavy type locomotives are to be added to the present equipment for handling the ore more economically. The cost of mining underground ores from the Ruth mine was \$1.016 a ton, which is higher than in 1927 due to increased expense for underground maintenance and for handling ores from the Ingersoll section on the sixth level of the Ruth mine which is somewhat remote from the hoisting shaft. The cost of milling in 1928, exclusive of depreciation and all taxes, but including all other expenses of every kind, was 46.6 cents a ton.

Further improvements in equipment will give the McGill concentrator an economic capacity of 18,000 tons of ore a day, with finer grinding than was previously obtained when 15,000 tons was treated daily. A 7,500-kilowatt turbo-generator will be installed in the McGill power plant to provide enough power to operate the concentrator and smelter at the full capacity of 18,000 tons of ore a day.

The Consolidated Coppermines Corporation operated the Morris-Brooks, Ora, and Richard properties the entire year, and according to the printed annual report mined 961,487 dry tons of ore compared with 652,026 tons in 1927, most of which was milled each year at the Nevada Consolidated concentrator. Besides the low-grade copper ore, which was the chief product, first-class copper ore of good grade was shipped to McGill and to Utah for smelting. The several hundred tons of gold ore shipped from lessee operations contained very little lead and no zinc. The copper ore of both milling and shipping grade (961,487 tons) yielded 21,551,936 pounds of copper, 14,097.08 ounces of gold, and 36,853 ounces of silver. Development of the property has increased the ore reserves of the company, and these conditions are reviewed in the company's printed report for 1928, part of which follows:

The two major undertakings, Emma Nevada and Alpha, on which we have expended our main efforts during the past year, are now so advanced that a small production has already begun which will be rapidly augmented hereafter. With minor additions to plants it will now be possible to materially increase the actual mining of ores, as well as exploratory work, with ultimate corresponding profit to the Corporation. We are accordingly rapidly changing from a development to an operating basis.

During 1928 over one million five hundred thousand dollars was spent on construction, equipment and deferred development. * * *

The Corporation now owns in the Robinson Mining District of Nevada 202 patented mining claims and 32 unpatented mining claims, comprising 3,557.493 acres; in addition it owns 5,750.097 acres of surface and ranch lands, as well as two valuable water rights. Fourteen unpatented claims, adjoining this Corporation's holdings to the south and southwest of Nevada Consolidated Copper Company's shovel pit, were acquired by location during the year, making our total holdings in this promising region approximately 500 acres. * * *

Development work and active mining were carried on in the Morris-Brooks mine during 1928. The total production during the year was 627,571 tons averaging 1.28 per cent copper, as compared to the 1927 production of 221,181 tons averaging 1.32 per cent copper. The mining operations have proven up extensions to the already known orebodies in these mines and the increased operations, together with better metal prices, have permitted the mining of lower grade ores than was previously contemplated.

A drift is being driven on the 360-foot level in a northwesterly direction to open up and prepare for mining the known ores of the Old Glory mine, as well as to open up orebodies that have been proven by recent churn drilling to exist between the Morris and Old Glory orebodies. * * *

Preparations were started this year for retimbering the Alpha shaft preparatory to unwatering. Unusual difficulties were encountered in a badly fractured, oxidized, leached and caved section, making it necessary to open up the old Giroux shaft, thus providing entrance to the main shaft on the 1,000-foot level, where suitable supports were erected under the caved section. The main shaft is now opened up to the 1,000-foot level. * * *

Development work has been done on both 6,470-foot and 6,660-foot levels of the Emma Nevada mine.

Extraction drifts from the main drift on the 6,470-foot level have been started toward the ore belonging to Nevada Consolidated Copper Company in the vicinity of the contract plane. Connection has also been made with a drift from the Nevada Consolidated Copper Company's Wedge shaft. It was found necessary and economical to concrete the main drift for a distance of approximately 916 feet. * * *

A drift has been started on the Lane No. 1 claim, in order to explore the upper horizons of the ground acquired during the last two years to the south of the Nevada Consolidated Copper Company's pit, where lead and silver ores, carrying combined values up to \$100 per ton, were encountered at or near the surface. * * *

Lessees have been working part of the year on the Isaacs, Bullion, Elijah, and Saxton claims in the Lane City territory and shipments of lead, silver, and gold ores have been made to the smelters from these leases. * * *

Churn drilling has continued and was prosecuted at intervals during the year. A total of 17,455 feet was drilled. This comprises the total footage of 30 holes.

The purpose of this year's churn drilling program was to extend or delimit some of the principal known orebodies and to prospect favorable areas for new orebodies. Two holes drilled in the limestone area furnished valuable information regarding general geologic structure and should be of material aid in directing exploratory work in the limestones. Of the 30 holes drilled, 12 holes cut ore of commercial grade.

3,234 feet of Leyner prospect holes were drilled. These holes were of great aid in directing development and also materially increased our ore reserves.

Ward district (Taylor).—One car lot of oxidized lead ore was shipped by the Walter W. Mining Co. from the Ward mine. The ore assayed 7 ounces of silver to the ton, 12 per cent of lead, and 26 per cent of iron.

White Pine district (Hamilton).—Thirteen producers in the White Pine district reported an output of 1,961 tons of ore and old tailings in 1928, compared with 3,403 tons of ore in 1927 reported by 10 producers. The output in 1928 consisted of 261 tons of lead-silver ore, shipped directly to the smelter, and 1,700 tons of old silver tailings treated by cyanidation. The tailings were from the Treasure Hill and Smoky Hill mill dumps. Other properties producing small lots of lead ore were the Dog Star, Manilla, Nevada Bell, Roosevelt, McEllin, and Rocco Homestake.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH ¹

(MINE REPORT)

By C. N. GERRY ²

SUMMARY

The output of gold, silver, copper, lead, and zinc from Utah mines in 1928 was valued at \$79,258,904; the increase of \$5,632,272 in comparison with 1927 was due chiefly to the increase in the price of copper, particularly during the last quarter of the year. There were 121 producing lode mines and 3 placers in 1928, compared with 123 lode mines and no placers in 1927. The output of ore and the quantity of gold and copper increased considerably, but the quantity of silver, lead, and zinc decreased. The output of gold increased from \$4,008,451 to \$4,394,001 and copper from 256,933,278 to 293,-235,039 pounds; silver decreased from 18,606,950 to 17,072,852 ounces, lead from 302,570,040 to 291,830,021 pounds, and zinc from 99,185,-443 to 93,857,352 pounds.

Compared with other States, Utah was first in the output of silver in 1928 (as it has been since 1920), second again in copper and lead, fifth again in zinc, and fifth in gold. Salt Lake County, which includes the Bingham district, again led in total value of metal output in 1928 as well as in the production of gold, copper, lead, and zinc. Wasatch County, which includes part of the Park City region, was second in the total value of the five metals, second in the output of zinc, third in the output of gold, and fourth in the output of silver, copper, and lead. Utah County, which includes a large part of the Tintic district, was third in the total value of the five metals, first in the output of silver, second in the output of gold and lead, and fifth in the output of copper. Summit County, which includes part of the Park City region, was fourth in the total value of the five metals, third in the output of silver, copper, lead, and zinc, and fifth in the output of gold.

Since 1864 Utah has yielded an output of the five metals as follows: Gold, \$126,269,939; silver, 546,462,393 fine ounces; copper, 4,067,061,-417 pounds; lead, 6,265,493,536 pounds; and zinc, 598,861,581 pounds. The total value of this output has been \$1,610,514,947.

Published dividends of 9 mining companies amounted to \$18,307,-894 in 1928, making a recorded total of \$312,842,664 paid to stockholders since mining became profitable. In 1927 dividends paid by 7 companies amounted to \$15,463,401. More than 23 per cent of the value of the metal output in 1928 was paid in dividends, and more than 19 per cent of the metal output since 1864 has been paid in dividends. The dividends stated above for 1928 do not include

¹ Work on manuscript completed January, 1930.

² The valuable assistance of B. N. Lowry and Paul Luff, of the Bureau of Mines, is acknowledged.

\$2,931,127 paid by the United States Smelting, Refining & Mining Co., which controls mines in other States and in Mexico besides those at Eureka and Bingham, Utah. The 9 companies that contributed to the total dividends in 1928 were the Utah Copper, Park Utah Consolidated, Tintic Standard, Silver King Coalition, Bingham Mines, North Lily, Utah-Apex, Chief Consolidated, and Plutus. The North Lily Mining Co., a new company operating property in the eastern part of the Tintic district, paid its first dividend in October, 1928.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919-----	\$1.12	\$0.186	\$0.053	\$0.073	1924-----	\$0.670	\$0.131	\$0.080	\$0.065
1920-----	1.09	.184	.080	.081	1925-----	.694	.142	.087	.076
1921-----	1.00	.129	.045	.050	1926-----	.624	.140	.080	.075
1922-----	1.00	.135	.055	.057	1927-----	.567	.131	.063	.064
1923-----	.82	.147	.070	.068	1928-----	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in Utah, 1919-1928

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919-----	179	-----	6,745,423	104,464.41	\$2,159,471	11,649,961	\$13,047,956
1920-----	161	3	6,800,180	97,454.15	2,014,556	13,106,976	14,286,604
1921-----	134	4	2,137,522	85,619.15	1,769,905	12,251,998	12,251,998
1922-----	147	7	5,560,034	111,110.36	2,296,855	17,271,100	17,271,100
1923-----	146	4	12,752,998	148,824.86	3,076,483	19,137,470	15,692,725
1924-----	136	2	13,640,618	146,486.85	3,028,152	17,253,692	11,559,974
1925-----	179	-----	14,479,247	177,803.08	3,675,516	21,276,689	14,766,022
1926-----	164	2	15,856,144	182,762.98	3,778,046	19,358,581	12,079,755
1927-----	123	-----	15,757,074	193,908.82	4,008,451	18,606,950	10,550,141
1928-----	121	3	18,427,117	212,559.79	4,394,001	17,072,852	9,987,618

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919----	124,061,807	\$23,075,496	123,829,051	\$6,562,940	4,431,024	\$323,465	\$45,169,328
1920----	116,931,238	21,515,348	140,838,113	11,267,049	8,157,739	660,777	49,744,334
1921----	30,891,403	3,984,991	89,187,269	4,013,427	69,390	3,469	22,023,790
1922----	97,193,850	13,121,170	135,332,144	7,443,268	5,119,410	291,806	40,424,199
1923----	222,393,572	32,691,855	203,447,793	14,241,346	11,330,913	770,502	66,472,911
1924----	242,138,165	31,720,100	233,910,875	18,712,870	18,562,172	1,206,541	66,227,637
1925----	236,486,540	33,581,089	306,669,824	26,680,275	52,611,732	3,998,492	82,701,394
1926----	257,464,482	36,045,027	295,270,025	23,621,602	95,179,380	7,138,454	82,662,884
1927----	256,933,278	33,658,259	302,570,040	19,061,913	99,185,443	6,347,868	73,626,632
1928----	293,235,039	42,225,846	291,830,021	16,926,141	93,857,352	5,725,298	79,258,904

GOLD

The mine production of gold in Utah in 1928, the largest production since 1911, increased nearly 10 per cent over 1927. Most of the gold came from Salt Lake, Utah, Wasatch, and Juab Counties, named in order of output. The gain was particularly notable in Salt Lake and Utah Counties and was due to the increased output of copper ore and siliceous gold ore. The decrease in the production of gold in Juab and Wasatch Counties was unusually large, especially from the Mammoth tailing dump, Chief Consolidated, and Park Utah Consolidated properties. Large increases in the output of gold were made by the Utah Copper, Eureka Lilly, North Lily, Deer Trail, Eureka Standard, Live Yankee, and Bingham Metals properties.

Gold in Utah is now produced almost entirely as a by-product from smelting and refining copper and lead ores and concentrates and from residues from zinc products.

The Utah Copper property, at Bingham, was the largest producer of gold in Utah in 1928, the property of the Park Utah Consolidated Mines Co. was second, and the Bingham property of the United States Smelting, Refining & Mining Co., Utah-Delaware, Eureka Lilly, Utah-Apex, North Lily, Tintic Standard, Deer Trail, Chief Consolidated, Silver King Coalition, Bingham Metals, Eureka Standard, and Live Yankee mines followed in order of production.

SILVER

In 1928 Utah was again the largest producer of silver in the United States, although the quantity was less by more than 8 per cent than the output of 1927. Its position is notable as compared with that of other Western States, although the output has been gradually decreasing since the record output of 1925. Utah County led in output, followed closely by Salt Lake, Summit, and Wasatch Counties. The decrease was especially notable in the Tintic district, Juab County; there were also decreases in both the Park City region and the Bingham district. The output of many of the larger producers decreased considerably, especially that of the Park Utah Consolidated Mines Co. Good increases were made by the Silver King Coalition, North Lily, Utah Copper, and New Quincy companies. As in recent years, most of the silver was recovered at plants in the East from bullion produced from crude ore and concentrates treated at the Garfield, Murray, Midvale, and International smelters. Utah has no copper or lead refineries, and no silver bullion or precipitates were recovered by cyanidation or chlorination.

Nine properties in Utah each produced more than 700,000 ounces of silver in 1928; these were the Tintic Standard, in the Tintic district; the Park Utah Consolidated and the Silver King Coalition, in the Park City region; the Utah Copper Co., at Bingham; the Bingham Mines Co., operating properties at Bingham and in the Tintic district; the Ontario Silver, at Park City; the North Lily and Plutus, in the Tintic district; and the property of the United States Smelting, Refining & Mining Co., at Bingham.

COPPER

In 1928 Utah again ranked second among the States as a producer of copper, and the output was the largest ever recorded for the State. The relative advance in the output of copper in Utah, compared with the output in Montana and in certain mines and districts in Arizona, is due to the strides made recently by the Utah Copper Co., at Bingham. This company increased its copper output more than 17 per cent in 1928 and was the largest single producer of copper in the United States exceeding even the output of the group of copper mines at Butte, worked by the Anaconda Copper Mining Co. More than 98 per cent of the copper produced in Utah came from the Bingham or West Mountain district, Salt Lake County; the output of the Park City region, Summit and Wasatch Counties, and that of the Tintic district, Juab and Utah Counties, followed but was comparatively small.

Crude ore shipped to smelters yielded 8,967,039 pounds of copper, compared with 10,847,075 pounds in 1927. Of the copper from crude copper ore smelted, 2,660,055 pounds came from sulphide ores and 2,079,606 pounds from oxidized ores; of the lead ores smelted, sulphide ores yielded 1,906,586 pounds of copper and oxidized ores 415,583 pounds. The copper-lead ores smelted were chiefly sulphide; they yielded 19,482 pounds of copper. The dry and siliceous ore, used chiefly as a flux at smelting plants, yielded 1,885,727 pounds of copper, compared with 2,061,677 pounds in 1927. The low-grade disseminated ores that were concentrated yielded 271,910,945 pounds of copper, compared with 232,284,968 pounds in 1927.

The leading copper producers in Utah in 1928 were, in order of output, the Utah Copper Co. (which reported 273,823,351 net pounds, an increase from 233,002,661 net pounds reported in 1927), Utah-Apex, Ohio Copper, Utah-Delaware, Silver King Coalition, Bingham Mines Co., and Park Utah Consolidated. In addition to considerable prospecting from the Mascotte tunnel the Ohio Copper Co., at Lark, continued to leach in place the caved area of the mine; the yield of copper from precipitates or cement copper, however, was slightly less than that of 1927.

LEAD

In 1928 Utah again ranked second among the States as a producer of lead, although the quantity decreased more than 3 per cent from that of 1927 because of few shipments of lead-zinc ore from the Bingham district. There was a decided decrease in the production of lead from the western part of the Tintic district, in Juab County, but a large increase from the eastern part of the district, in Utah County. The production of lead in the Park City region was upheld by the increase in the output of the Silver King Coalition and New Quincy mines, but the output of the Park Utah Consolidated Mines Co. was decidedly less than in 1927.

The Bingham or West Mountain district produced 104,750,662 pounds of lead, compared with 111,015,187 pounds in 1927; most of the lead output at Bingham came from the property of the United States Smelting, Refining & Mining Co., the Utah-Delaware mine,

and the Utah-Apex mine. The output of these three properties, however, decreased decidedly, but the Utah Copper Co. made a good increase. The Park City region produced 82,854,090 pounds, compared with 82,805,275 pounds in 1927; the Tintic district produced 88,192,591 pounds, compared with 90,089,355 pounds; the combined production of the Ophir and Rush Valley districts (chiefly the latter), Tooele County, decreased from 15,006,795 to 14,645,679 pounds; the output in Beaver County decreased from 1,186,328 to 668,332 pounds; and the combined production of the Big and Little Cottonwood districts, Salt Lake County, decreased from 2,017,283 to 292,975 pounds. In the Tintic district, the large increase in the output of lead from the North Lily and Eureka Lilly properties partly offset the decrease in the output of lead from the Tintic Standard, Plutus, and Chief Consolidated properties.

The Park Utah Consolidated property in the Park City region again ranked first in lead output in Utah in 1928. It was followed in order by the Silver King Coalition mine, also in the Park City region; the Tintic Standard property (including the Iron Blossom mine) in the Tintic district; the United States Smelting, Refining & Mining Co.'s property, at Bingham; the North Lily mine, in the Tintic district; and the Utah-Delaware property, at Bingham. Each of these was credited with producing more than 24,000,000 pounds of lead. Next in rank were the Utah-Apex, Bingham Mines Co., Plutus, Utah Copper, Combined Metals, Eureka Lilly, and Blue-stone properties.

ZINC

The mine production of zinc in Utah in 1928 decreased more than 5 per cent from the record output made in 1927 as a result of the large decrease in the shipments of lead-zinc ore from the Bingham and Rush Valley districts. The production from the Park City region increased from 44,856,214 to 47,569,849 pounds, but that from the Bingham district decreased from 49,097,827 to 44,492,643 pounds. These two regions are the chief zinc-producing areas in Utah. The increase in the output of zinc in the Park City region was due to the large shipments of lead-zinc mill ore from the New Quincy property, the latest mine to join the ranks of the large producers in the Park City region. In the Bingham district the large decreases in the output of zinc from the Utah-Delaware mine and the property of the United States Smelting, Refining & Mining Co. discounted the increases of the Utah Copper, Utah-Apex, and Utah Metal & Tunnel properties.

The Park Utah Consolidated Mines Co. operating in the Park City region again ranked first in zinc output in Utah in 1928, followed by the mines of the United States Smelting, Refining & Mining Co., at Bingham. Other large zinc producers were the Utah-Apex, Silver King Coalition, Utah-Delaware, New Quincy, Utah Copper, Utah Metal & Tunnel, Combined Metals, and Ontario Silver properties. The work of treating lead-zinc-iron ores, which has become an established business in Utah, is done largely at 3 custom flotation mills within a radius of 25 miles of Salt Lake City. The zinc product is shipped to electrolytic zinc plants at Great Falls or Anaconda, Mont., and the lead and iron products are smelted locally.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1928, by counties

County	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value
Beaver.....	161.23	\$3,333	28,216	\$16,506
Box Elder.....			67	39
Garfield.....	10.45	216		
Grand.....	28.49	589	6	4
Juab.....	12,902.10	266,710	2,339,009	1,368,320
Millard.....			368	215
Piute.....	3,885.38	80,313	9,443	5,524
Salt Lake.....	141,011.72	2,914,971	3,762,697	2,201,178
San Juan.....	7.06	146		
Sanpete.....			35	21
Summit.....	4,575.11	94,576	3,679,405	2,152,452
Tooele.....	3,767.74	77,886	273,768	160,154
Utah.....	24,532.46	507,131	3,913,411	2,289,345
Wasatch.....	21,659.04	447,732	3,066,421	1,793,856
Washington.....	19.01	393	6	4
Total, 1927.....	212,559.79	4,394,001	17,072,852	9,987,618
	193,908.82	4,008,451	18,606,950	10,550,141

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Beaver.....	13,517	\$1,946	668,332	\$38,763	240,812	\$14,689	\$75,237
Box Elder.....	85	12	31,385	1,820			1,871
Garfield.....							216
Grand.....							593
Juab.....	1,747,310	251,613	19,785,802	1,147,576	41,563	2,535	3,036,754
Millard.....	283	41	35,987	2,087			2,343
Piute.....	8,494	1,223	19,273	1,118			88,183
Salt Lake.....	287,828,061	41,447,241	105,103,293	6,095,991	44,510,260	2,715,126	55,374,507
San Juan.....							146
Sanpete.....	226	33	295	17			71
Summit.....	1,470,948	211,816	41,469,235	2,405,216	11,917,602	726,974	5,591,034
Tooele.....	167,143	24,069	14,773,417	856,858	1,494,868	91,187	1,210,154
Utah.....	830,428	119,582	68,558,147	3,976,373			6,892,431
Wasatch.....	1,168,544	168,270	41,384,855	2,400,322	35,652,247	2,174,787	6,984,967
Washington.....							397
Total, 1927.....	293,235,039	42,225,846	291,830,021	16,926,141	93,857,352	5,725,298	79,258,904
	256,933,278	33,658,259	302,570,040	19,061,913	99,185,443	6,347,868	73,626,632

Ore, old tailings, etc., sold or treated, lode mines producing, and average value of ore, etc., in gold and silver in Utah, 1927-28, by counties

County	Ore, old tailings, etc. (short tons)		Lode mines producing		Average value per ton in gold and silver	
	1927	1928	1927	1928	1927	1928
Beaver.....	9,357	2,810	6	6	\$3.54	\$7.06
Box Elder.....	126	70	4	3	.34	.56
Garfield.....	10		1		7.80	
Juab.....	300,501	170,477	28	21	9.36	9.59
Millard.....		223		1		.96
Morgan.....	127		1		2.24	
Piute.....	35	6,475	1	3	10.94	13.26
Salt Lake.....	14,524,824	17,253,593	35	33	.32	.30
Sanpete.....		13		2		1.62
Summit.....	347,087	399,082	8	9	5.44	5.63
Tooele.....	68,790	48,716	23	25	3.54	4.89
Utah.....	146,953	213,631	12	12	14.81	13.09
Wasatch.....	359,264	332,021	4	5	7.55	6.75
Washington.....		6		1		66.17
Total, 1927.....	15,757,074	18,427,117	123	121	.92	.78

MINING INDUSTRY

The outstanding features of the industry in Utah were the improvements and increased production of the Utah Copper Co., which made a record output of copper and greatly reduced its cost of operating. Although the metal prices of lead and zinc in 1928 were less than those of 1927, dividends paid by Utah mining companies were larger, and the value of recovered metals increased more than \$5,600,000. In general, conditions for both mining and development work were unusually good. The output of several large mines, such as the Tintic Standard, the Bingham property of the United States Smelting, Refining & Mining Co., the Utah-Apex, Utah-Delaware, Plutus, Chief Consolidated, and Park Utah Consolidated properties, was much less than in recent years, but there were several notable examples of increased production, such as that of the Utah Copper, Silver King Coalition, North Lily, Eureka Lilly, New Quincy, Live Yankee, Deer Trail, and Bluestone mines. Two comparatively new properties were added to the list of large producers—the New Quincy mine, at Park City, and the Eureka Standard property, in the Tintic district. The Deer Trail mine, south of Marysvale, again became a producer of ore containing chiefly gold. Vigorous development work was done at Bingham, in the eastern sections of the Tintic district and Park City region, and in several outlying districts, such as Ophir, Stockton, and Silver Reef. The output of ore was larger than that in 1927, the notable increase being from the Bingham district. There was also a good increase in the output of copper ore and siliceous gold ore but a decrease in lead-zinc ore marketed, corresponding in general to the drop in the price of lead and zinc.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in Utah, 1919–1928, with content in terms of recovered metals

DRY AND SILICEOUS ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	239,688	25,216.63	3,645,909	2,758,479	1,438,014	-----
1920.....	291,020	33,347.99	3,955,771	2,116,803	6,282,276	-----
1921.....	376,472	29,554.10	6,088,635	1,371,654	8,735,063	-----
1922.....	414,359	38,353.62	8,110,733	2,635,080	8,693,250	-----
1923.....	346,425	32,714.51	6,737,300	2,852,586	6,358,703	-----
1924.....	282,226	27,098.75	4,749,144	1,998,016	7,137,005	-----
1925.....	389,030	34,269.82	4,434,524	3,926,172	10,134,106	-----
1926.....	301,213	24,097.08	3,365,644	2,970,610	6,408,867	-----
1927.....	245,344	22,709.99	2,577,357	3,072,539	5,713,355	-----
1928.....	211,758	25,573.78	2,355,975	2,293,800	5,705,697	-----

COPPER ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	5,884,118	38,873.71	586,417	116,312,084	1,231	-----
1920.....	5,778,373	31,845.51	452,915	108,645,375	31,461	-----
1921.....	1,357,857	14,384.74	229,556	27,321,481	255,567	-----
1922.....	4,509,384	36,398.64	473,284	91,088,007	252,970	-----
1923.....	11,519,727	84,203.12	867,618	214,305,888	30,852	-----
1924.....	12,357,366	83,444.56	887,541	234,954,343	199,275	-----
1925.....	12,575,265	87,168.24	1,959,790	223,484,426	701,063	-----
1926.....	13,949,866	100,853.65	1,281,767	245,328,789	582,261	-----
1927.....	13,879,173	100,057.71	1,138,014	244,279,301	242,552	-----
1928.....	16,631,757	115,164.28	1,275,682	282,899,020	317,511	-----

¹ Includes metal saved from precipitates.

Ore, old tailings, etc., sold or treated in Utah, 1919-1928, with content in terms of recovered metals—Continued

LEAD ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	435, 541	17, 555. 14	6, 664, 219	4, 157, 256	95, 881, 706	-----
1920.....	559, 896	18, 185. 95	7, 895, 007	4, 961, 482	111, 133, 846	-----
1921.....	401, 429	41, 628. 44	5, 893, 497	2, 088, 255	79, 519, 436	69, 390
1922.....	507, 450	17, 853. 25	8, 183, 741	2, 945, 328	107, 416, 311	-----
1923.....	645, 991	21, 365. 84	10, 648, 952	4, 494, 047	168, 875, 684	16, 535
1924.....	729, 219	24, 380. 08	9, 936, 956	4, 138, 013	179, 798, 884	403, 789
1925.....	699, 361	27, 002. 58	10, 318, 309	5, 874, 744	185, 821, 166	-----
1926.....	383, 857	19, 095. 25	7, 307, 599	4, 038, 262	130, 674, 816	-----
1927.....	337, 734	19, 868. 69	7, 214, 271	2, 665, 402	131, 088, 261	-----
1928.....	341, 194	26, 727. 17	6, 241, 616	2, 430, 055	134, 193, 203	-----

COPPER-LEAD ORE

1919.....	1, 924	32. 56	38, 936	125, 645	746, 640	-----
1920.....	6, 389	223. 78	172, 401	407, 397	2, 155, 329	-----
1921.....	1, 764	31. 84	40, 309	110, 013	677, 203	-----
1922.....	1, 272	35. 14	20, 919	125, 233	137, 399	-----
1923.....	971	24. 96	30, 924	90, 624	164, 495	-----
1924.....	19	1. 76	462	5, 257	3, 294	-----
1925.....	13	. 04	55	1, 370	1, 924	-----
1926.....	-----	-----	-----	-----	-----	-----
1927.....	73, 878	1, 016. 36	169, 111	2, 218, 716	3, 902, 896	-----
1928.....	45, 365	1, 632. 79	94, 304	1, 194, 110	2, 905, 485	-----

ZINC ORE AND LEAD-ZINC ORE ¹

1919.....	184, 152	22, 786. 37	714, 480	708, 343	25, 761, 460	4, 431, 024
1920.....	164, 502	13, 829. 01	630, 875	800, 181	21, 235, 201	8, 157, 739
1921.....	-----	-----	-----	-----	-----	-----
1922.....	127, 589	18, 366. 67	482, 417	400, 202	18, 832, 214	5, 119, 410
1923.....	239, 884	10, 490. 94	852, 673	650, 427	28, 018, 059	11, 314, 378
1924.....	271, 788	11, 550. 48	1, 679, 588	1, 042, 536	46, 772, 417	18, 158, 383
1925 ²	815, 578	29, 362. 40	5, 564, 011	3, 199, 828	110, 011, 565	52, 611, 732
1926.....	1, 221, 208	38, 700. 84	7, 403, 570	5, 126, 821	157, 604, 081	95, 179, 380
1927.....	1, 220, 945	50, 256. 07	7, 508, 197	4, 697, 320	161, 622, 976	99, 185, 443
1928.....	1, 197, 043	43, 415. 77	7, 105, 269	4, 418, 054	148, 708, 125	93, 857, 352

¹ Includes copper-lead-zinc ore in 1925, as follows: 563 tons, yielding 5.07 ounces of gold, 3,957 ounces of silver, 10,194 pounds of copper, 136,737 pounds of lead, and 212,159 pounds of zinc.

Ore, old tailings, etc., sold or treated in Utah in 1928, with content in terms of recovered metals

Source	Mines producing	Ore, old tailings, etc.		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore.....	8	14, 704	0. 08	8, 700. 95	4. 09	75, 023	0. 44
Dry gold and silver ore.....	9	1 36, 063	. 19	7, 848. 56	3. 69	189, 252	1. 11
Dry silver ore.....	32	2 160, 991	. 87	9, 024. 27	4. 25	2, 091, 700	12. 25
Copper ore.....	18	16, 631, 757	90. 26	115, 164. 28	54. 18	1, 275, 682	7. 47
Lead ore.....	82	3 341, 194	1. 85	26, 727. 17	12. 57	6, 241, 616	36. 56
Copper-lead ore.....	4	4 45, 365	. 25	1, 632. 79	. 77	94, 304	. 55
Lead-zinc ore.....	30	5 1, 197, 043	6. 50	43, 415. 77	20. 43	7, 105, 269	41. 62
Total, lode mines.....	6 121	18, 427, 117	100. 00	212, 513. 79	99. 98	17, 072, 846	100. 00
Total, placers.....	3	-----	-----	46. 00	. 02	6	-----
Total, 1927.....	124	18, 427, 117	100. 00	212, 559. 79	100. 00	17, 072, 852	100. 00
	123	15, 757, 074	-----	193, 908. 82	-----	7 18, 606, 950	-----

¹ Includes 24,230 tons of old tailings sold to a smelter.

² Includes 29,572 tons of old tailings sold to a smelter.

³ Includes 12 tons of old tailings sold to a smelter and 130 tons of old tailings concentrated.

⁴ Includes 10 tons of old slag sold to a smelter.

⁵ Includes 185,107 tons of old tailings concentrated.

⁶ A mine producing more than one class of ore is counted but once in arriving at total for all classes.

⁷ Includes 21 ounces of silver saved from precipitates.

Ore, old tailings, etc., sold or treated in Utah in 1928, with content in terms of recovered metals—Continued

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore.....	86, 114	0. 03	253, 032	0. 09	-----	-----
Dry gold and silver ore.....	647, 808	. 22	286, 859	. 10	-----	-----
Dry silver ore.....	1, 559, 878	. 53	5, 165, 806	1. 77	-----	-----
Copper ore.....	⁸ 282, 899, 020	96. 47	317, 511	. 11	-----	-----
Lead ore.....	2, 430, 055	. 83	134, 193, 203	46. 01	-----	-----
Copper-lead ore.....	1, 194, 110	. 41	2, 905, 485	. 99	-----	-----
Lead-zinc ore.....	4, 418, 054	1. 51	148, 708, 125	50. 93	93, 857, 352	100. 00
	⁸ 293, 235, 039	100. 00	291, 830, 021	100. 00	93, 857, 352	100. 00
Total, 1927.....	⁹ 256, 933, 278	-----	302, 570, 040	-----	99, 185, 443	-----

⁸ Includes 6,207,777 pounds of copper saved from precipitates.

⁹ Includes 6,046,915 pounds of copper saved from precipitates.

Value of metals from ore, old tailings, etc., sold or treated in Utah in 1928, by kinds of ore

Kind of ore	Ore, old tailings, etc. (short tons)	Gold	Silver	Copper	Lead	Zinc	Total
Dry gold ore.....	14, 704	\$179, 864	\$43, 888	\$12, 400	\$14, 676	-----	\$250, 828
Dry gold and silver ore.....	36, 063	162, 244	110, 712	93, 284	16, 638	-----	382, 878
Dry silver ore.....	160, 991	186, 548	1, 223, 645	224, 623	299, 617	-----	1, 934, 433
Copper ore.....	16, 631, 757	2, 380, 657	746, 274 ¹	40, 737, 459	18, 415	-----	43, 882, 805
Lead ore.....	341, 194	552, 500	3, 651, 345	349, 928	7, 783, 206	-----	12, 336, 979
Copper-lead ore.....	45, 365	33, 753	55, 168	171, 952	168, 518	-----	429, 391
Lead-zinc ore.....	1, 197, 043	897, 484	4, 150, 582	636, 200	8, 625, 071	\$5, 725, 298	20, 040, 635
	18, 427, 117	4, 393, 050	9, 987, 614 ²	42, 225, 846	16, 926, 141	5, 725, 298	79, 257, 949
Total, 1927.....	15, 757, 074	4, 008, 451	10, 550, 141 ²	33, 658, 259	19, 061, 913	6, 347, 868	73, 626, 632

¹ Includes value of 6,207,777 pounds of copper saved from precipitates.

² Includes value of 21 ounces of silver and 6,046,915 pounds of copper saved from precipitates.

GOLD ORE

The metals recovered from gold ore were valued at \$250,828, an average of \$17.06 a ton. The output of ore increased decidedly and yielded on the average 0.592 ounce of gold and 5.10 ounces of silver to the ton and a little copper and lead. More than 90 per cent of the gold ore was mined from three properties—the Deer Trail mine, near Marysvale; the Eureka Standard property, near Dividend; and the Utah Metal & Tunnel property, at Bingham.

GOLD AND SILVER ORE

Nine mines in 1928, compared with five in 1927, produced siliceous gold and silver ore and old tailings, which yielded on the average 0.218 ounce of gold and 5.25 ounces of silver to the ton, 0.90 per cent of copper, and 0.40 per cent of lead. Most of the gold and silver material was old tailings shipped from the Mammoth dump in the Tintic district, Juab County; shipments of old tailings from this dump decreased materially in 1928.

SILVER ORE

Dry and siliceous silver ore and old tailings were produced by 32 mines in 1928, compared with 26 in 1927, and yielded on the average \$1.16 in gold, 12.99 ounces of silver, 9.69 pounds of copper, and 32.09 pounds of lead to the ton. The metals recovered from the ore and old tailings were valued at \$1,934,433, an average of \$12.02 a ton. Sixteen mines in the Tintic district in Juab and Utah Counties produced 129,147 tons of silver ore and old tailings, or 80 per cent of the total. The largest producers of this material were the Tintic Standard, Eureka Hill tailings dump, Bingham Mines Co., Eagle & Blue Bell, and Mammoth properties.

COPPER ORE

The output of copper ore increased decidedly in 1928 and represented 90 per cent of the State total. The ore yielded on the average 0.007 ounce of gold, 0.077 ounce of silver, 16.636 pounds of copper, and a little lead to the ton, and the average value in metals per ton was \$2.58. Salt Lake County produced nearly all the copper ore, chiefly from the Utah Copper property, at Bingham. Other leading producers of copper ore were the Utah-Delaware and Utah-Apex properties, also at Bingham.

LEAD ORE

The metals recovered from lead ore and old tailings in 1928 were valued at \$12,336,979, an average of \$36.16 to the ton. The output of ore and old tailings increased in 1928 and averaged 0.078 ounce of gold and 18.29 ounces of silver to the ton, 0.356 per cent of copper, and 19.665 per cent of lead. Sixty-one per cent of this material was produced from 17 mines in the Tintic district, and more than 20 per cent was produced from 16 mines in the Bingham district. There were unusually large decreases in the output of lead ore from the Victoria, Dalton & Lark (Bingham Mines Co.), Chief Consolidated, Mammoth, Plutus, and Tintic Standard properties, but there were good increases from the North Lily, Eureka Lilly, Utah Copper, Utah-Delaware, and Combined Metals mines. In 1927 there were 86 mines producing lead ore, etc., with a value in metals of \$13,108,942.

The largest producer of lead ore in Utah in 1928 was the Tintic Standard mine, at Dividend, in the Tintic district. It was followed in order by the North Lily and Plutus mines, also in the Tintic district; the Bingham Mines, at Bingham; the Eureka Lilly mine, in the Tintic district; the Combined Metals property, at Bauer; the Silver King Coalition mine, at Park City; the Utah Copper mine, at Bingham; and the Bluestone mine, near Stockton, in the Rush Valley district.

COPPER-LEAD ORE

Four mines in 1928 produced copper-lead ore which, together with a small quantity of slag, yielded on the average 0.036 ounce of gold and 2.08 ounces of silver to the ton, 1.316 per cent of copper, and 3.20 per cent of lead. The metals recovered from the ore and slag

were valued at \$429,391, or an average of \$9.47 a ton. Most of the copper-lead ore was produced from the Utah-Apex mine, at Bingham; the Cardiff property, in the Big Cottonwood district, also produced copper-lead ore.

LEAD-ZINC ORE

All the zinc produced by Utah mines in 1928 was recovered from lead-zinc ore and old tailings. The output of this material was less than that in 1927 and yielded on the average 0.036 ounce of gold and 5.936 ounces of silver to the ton, 0.18 per cent of copper, 6.21 per cent of lead, and 3.92 per cent of zinc. Nearly 41 per cent of it came from the Bingham or West Mountain district and more than 58 per cent from the Park City region. The larger part of the output from these districts was concentrated at the custom flotation plants at Midvale, Bauer, and International, where ore from Utah and neighboring States was treated at the rate of more than 2,000 tons a day. Most of the zinc product from lead-zinc ore was shipped to the electrolytic zinc plants at Anaconda and Great Falls, Mont., but a large part of it went to Amarillo, Tex., and to Henryetta, Okla. The largest producers of lead-zinc ore in Utah in 1928 were the Park Utah Consolidated mines, in the Park City region; the property of the United States Smelting, Refining & Mining Co., at Bingham; the Silver King Coalition mine, at Park City; and the Utah-Delaware and Utah-Apex mines, both at Bingham. A large quantity of old tailings from Park City was also reconcentrated.

Ore, old tailings, etc., sold or treated in Utah in 1928, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Piute.....	6,445	3,878.17	8,785	8,095	6,066	-----
Salt Lake.....	2,612	515.31	14,410	62,883	217,001	-----
Utah.....	5,641	4,288.46	51,822	15,136	29,965	-----
Washington.....	6	19.01	6	-----	-----	-----
Total, 1927.....	14,704	8,700.95	75,023	86,114	253,032	-----
	4,226	3,390.88	26,151	60,720	29,767	-----

DRY GOLD AND SILVER ORE

Beaver.....	207	48.65	1,326	-----	-----	-----
Juab.....	33,140	4,672.00	168,261	571,111	284,000	-----
Piute.....	7	3.23	134	245	359	-----
Salt Lake.....	2,518	3,070.60	17,773	74,367	-----	-----
Tooele.....	2	1.08	25	-----	-----	-----
Utah.....	189	53.00	1,733	2,085	2,500	-----
Total, 1927.....	36,063	7,848.56	189,252	647,808	286,859	-----
	83,004	7,667.38	318,110	921,428	696,616	-----

Includes 24,230 tons of old tailings sold to a smelter.

Ore, old tailings, etc., sold or treated in Utah in 1928, by counties, with content in terms of recovered metals—Continued

DRY SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Juab.....	72,633	5,244.56	786,462	707,743	1,964,688	-----
Salt Lake.....	18,914	902.16	192,115	453,178	945,277	-----
Sanpete.....	12	-----	23	226	-----	-----
Summit.....	10,393	337.12	157,753	32,109	136,750	-----
Tooele.....	1,592	41.57	22,370	7,677	19,056	-----
Utah.....	56,514	2,246.85	898,311	349,627	2,057,035	-----
Wasatch.....	933	252.01	34,666	9,318	43,000	-----
Total, 1927.....	160,991	9,024.27	2,091,700	1,559,878	5,165,806	-----
	158,114	11,651.73	2,233,096	2,090,391	4,986,972	-----

COPPER ORE

Juab.....	2,807	493.59	45,476	196,676	9,357	-----
Salt Lake.....	16,624,374	111,662.41	1,213,749	282,584,862	262,500	-----
Tooele.....	20	.64	204	2,499	1,000	-----
Utah.....	4,556	3,007.64	16,253	114,983	44,654	-----
Total, 1927.....	16,631,757	115,164.28	1,275,682	282,899,020	317,511	-----
	13,879,173	100,057.71	1,138,014	244,279,301	242,552	-----

LEAD ORE

Beaver.....	2,038	109.15	23,020	11,458	498,349	-----
Box Elder.....	70	-----	67	85	31,385	-----
Juab.....	61,523	2,488.60	1,336,887	270,705	17,463,396	-----
Millard.....	223	-----	368	283	35,987	-----
Piute.....	23	3.96	524	154	12,848	-----
Salt Lake.....	70,497	4,524.69	618,323	1,128,183	24,073,232	-----
Sanpete.....	1	-----	12	-----	295	-----
Summit.....	19,108	956.28	985,135	474,727	10,763,853	-----
Tooele.....	37,308	3,597.14	225,202	142,153	13,580,091	-----
Utah.....	146,731	14,936.53	2,945,292	348,597	66,423,993	-----
Wasatch.....	3,672	130.82	106,786	53,710	1,309,774	-----
Total, 1927.....	341,194	26,727.17	6,241,616	2,430,055	134,193,203	-----
	337,734	19,868.69	7,214,271	2,665,402	131,088,261	-----

LEAD-ZINC ORE

Beaver.....	558	3.33	3,822	1,493	166,897	240,812
Juab.....	374	3.34	1,923	1,075	64,361	41,563
Salt Lake.....	489,320	18,703.85	1,612,071	2,331,044	76,702,884	44,510,260
Summit.....	369,581	3,301.72	2,536,517	964,112	30,568,632	11,917,602
Tooele.....	9,794	127.32	25,967	14,814	1,173,270	1,494,868
Wasatch.....	327,416	21,276.21	2,924,969	1,105,516	40,032,081	35,652,247
Total, 1927.....	1,197,043	43,415.77	7,105,269	4,418,054	148,708,125	93,857,352
	1,220,945	50,256.07	7,508,197	4,697,320	161,622,976	99,185,443

* Includes 21,912 tons of old tailings sold to a smelter.

* Includes 7,660 tons of old tailings sold to a smelter.

* Includes 6,207,777 pounds of copper saved from precipitates.

* Includes 21 ounces of silver and 6,046,915 pounds of copper saved from precipitates.

* Includes 130 tons of old tailings concentrated and 12 tons of old tailings sold to a smelter.

* Includes 159 tons of old tailings concentrated.

* Includes 180,000 tons of old tailings concentrated.

* Includes 4,948 tons of old tailings concentrated.

Zinc concentrates (as marketed from Utah mills) sold to smelters in 1928

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of concentrates	Recovered zinc
Zinc concentrates....	Beaver, Juab, Salt Lake, Summit, Tooele, and Wasatch.	<i>Short tons</i> 99, 593	<i>Pounds</i> 106, 836, 658	<i>Per cent</i> 53. 64	<i>Pounds</i> 93, 857, 352
		99, 593	106, 836, 658	53. 64	93, 857, 352

METALLURGIC INDUSTRY

In 1928 most of the ore (96 per cent) from Utah mines was concentrated; the resulting concentrates, with the first-class shipping ore, the old tailings, precipitates, etc., were smelted and yielded metals valued at \$79,257,744. Only a little ore was amalgamated; it yielded bullion containing gold and silver valued at \$205. In the last decade Utah has become an important smelting center, but no refining is done in the State. Large custom copper plants are operated at Garfield and International and lead plants at Midvale, Murray, and International; these smelters are discussed under Salt Lake and Tooele Counties.

The milling practice in Utah has improved steadily, especially the development of flotation at the large mills. At the two unusually large mills of the Utah Copper Co., near Garfield, the recovery of copper in concentrate has increased from 65 per cent during the war period to nearly 86 per cent in 1928. Regular operations were conducted at the custom mills treating lead-zinc ore at International, Midvale, and Bauer, and progress has been made at local plants by the Silver King Coalition, Utah-Apex, and Chief Consolidated companies.

In Utah 16 milling plants were running in 1928; 1 of these used jigs and tables with flotation cells, 4 used ordinary table concentration, and 11 used straight flotation. At 6 properties copper was precipitated from mine water or from ore leached in place, and most of this copper was recovered at the plants of the Ohio Copper Co. and Utah Copper Co., at Bingham, where regular leaching work was done.

A list of the large mills that were active in 1928 follows.

Large mills in Utah active in 1928

Name of company and location of mill	Capacity of mill	Actually treated	Kind of material treated	Product
	<i>Short tons per day</i>	<i>Short tons per day</i>		
Utah Copper Co., Magna and Arthur.	55,000	45,742	Copper ore.....	Copper concentrate.
International Smelting Co. (custom plant), International.	1,200	1,130	Lead-zinc-iron ore.	Lead, zinc, and iron concentrates.
United States Smelting, Refining & Mining Co. (custom plant), Midvale.	1,000	940	do.....	Do.
Combined Metals Reduction Co. (custom plant), Bauer.	200	160	do.....	Do.
Silver King Coalition Mines Co., Park City.	900	420	Lead-zinc ore.....	Silver-lead concentrate and zinc concentrate.
Chief Consolidated Mining Co., Eureka.	200	90	Lead ore.....	Lead concentrate.
Utah-Apex Mining Co., Bingham..	700	450	Lead-zinc ore and copper-lead ore.	Lead, zinc, copper, and copper-lead concentrates.
Park Utah Consolidated Mines Co. (Judge mill), Park City.	500	380	Lead-zinc ore.....	Lead concentrate and lead-zinc middling.

Flotation, which has made such interesting progress in Utah, is described in the revised quarterly³ of the School of Mines at Golden, Colo. This publication, which contains an interesting bibliography, discusses the theory and practice of flotation. A revised pamphlet giving data for 1927 is in preparation. Articles⁴ dealing with the fundamentals of flotation and particularly with certain pure minerals or combinations of minerals, including both metallic and nonmetallic minerals, were published in 1928.

A circular⁵ giving the flotation reagents used in 1927 and the kinds of ore treated by flotation, with the results, was issued by the Bureau of Mines in 1929. A report for 1928, giving the flotation reagents used and the kinds and grade of concentrates made by flotation from various kinds of ore, will be issued in similar form. A summary of the data on concentration, showing yield of concentrates, by kinds and by methods of recovery, is given on pages 494, 495.

Concentrates produced in Utah in 1928 yielded 73 per cent of the gold, 53 per cent of the silver, 95 per cent of the copper, 57 per cent of the lead, and all of the zinc. The quantity of copper concentrate decreased greatly, but the quantity of copper recovered therefrom increased as a result of the improvement in the grade of the concentrate. Zinc concentrates also decreased in quantity, but lead concentrates and copper-lead concentrates increased. The dry and siliceous concentrates were chiefly iron concentrates, containing gold and silver with a little copper and lead, made at custom flotation plants treating galena-sphalerite-pyrite ores.

Ore of all kinds shipped to the smelters amounted to 3 per cent of the total output and yielded 25 per cent of the gold, 45.5 per cent of the silver, 3 per cent of the copper, and 42 per cent of the lead. A large decrease was recorded in shipments of first-class lead ore, but a good increase in shipments of siliceous ore and a slight increase in shipments of copper ore.

The miscellaneous material treated (other than ore and old tailings concentrated, crude ore smelted, and a small lot of ore amalgamated) consisted of 53,824 tons of slag and old tailings shipped for smelting and copper from mine-water precipitates and from leaching of ore in place. This miscellaneous material yielded 3,962.56 ounces of gold, 259,257 ounces of silver, 6,616,590 pounds of copper, and 1,032,788 pounds of lead, valued in all at \$1,246,269; most of the gold, silver, and lead in this material came from old tailings from the Tintic district, in Juab County, whereas most of the copper was recovered from precipitate from ore leached and from mine waters from the Bingham or West Mountain district, in Salt Lake County. Part of the old tailings smelted came from the Park City region in Summit County.

³ Weinig, Arthur J., and Palmer, Irving A.. *The Trend of Flotation: Colorado Sch. Mines Quart.*, vol. 23, No. 2, April, 1928.

⁴ Gaudin, A. M., and others. *Flotation Fundamentals: Utah Eng. Exp. Station, Univ. of Utah, Tech. Papers 1, 4, and 5, 1928.*

⁵ Gaudin, A. M., *Consumption of Reagents Used in Flotation, 1927: Repts. of Investigations, Serial 2931, Bureau of Mines, 1929.*

Gross metal content of concentrates produced at all concentrating plants in Utah in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	56,781	6,062.47	136,887	256,967	2,017,977	-----
Copper.....	447,953	105,507.17	1,036,228	281,686,899	8,490	-----
Lead.....	184,068	37,349.46	7,313,278	4,691,927	168,874,654	-----
Zinc.....	99,593	5,162.14	485,198	785,051	2,964,083	106,836,658
Copper-lead.....	4,614	1,425.42	73,429	790,420	2,893,897	-----
	793,009	155,506.66	9,045,020	288,211,264	176,759,101	106,836,658

In 1928, 15 concentrating plants in Utah treated 17,861,682 tons of mill ore and old tailings from Utah mines. Crude mill ore amounted to 17,676,445 tons and old tailings to 185,237 tons. Of this tonnage, 17,719,894 tons, or 99.21 per cent, was treated by flotation; 138,298 tons, or 0.77 per cent, by combined tables and flotation; and the remainder, 3,490 tons, or 0.02 per cent, by tables without flotation equipment. The following table gives a summary of all ores and old tailings treated and a separation by classes of ore. The concentrates produced have been separated by classes and by the three methods of concentration.

Utah ores and old tailings concentrated in 1928, by classes of ore, etc., methods of concentration, and classes of concentrate

Class of material concentrated	Method of concentration	Ore and old tailings concentrated	Gross content of mill feed				
			Gold	Silver	Copper	Lead	Zinc
Ore:			<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Sulphide copper.....	Flotation.....	Short tons	148,868.23	1,426,777	328,520,640	3,212,500	1,475,770
Sulphide copper-lead.....	do.....	44,993	2,969.54	117,432	1,664,741	18,181,358	482,012
Oxidized lead.....	do.....	56,133	7,973.93	1,043,396	255,271	144,566,289	122,139,270
Sulphide lead-zinc.....	do.....	876,139	55,861.47	7,106,624	6,591,264		
Do.....							
Sulphide copper, sulphide lead, and oxidized lead.....	Tables and flotation.....	17,534,787	215,679.19	9,696,229	337,031,916	165,960,147	124,067,052
Total ore.....	Tables.....	138,298	3,042.56	901,703	389,773	30,204,283	23,850,000
		3,360	1,088.11	24,706	70,999	127,691	9,443
		17,676,445	220,409.86	10,622,638	337,492,688	196,292,121	147,956,495
Old tailings:							
Sulphide lead-zinc.....	Flotation.....	185,107	1,961.49	283,596	721,749	4,152,380	9,732,216
Sulphide lead.....	Tables.....	130	20.00	888	1,430	24,350	21,380
Total old tailings.....		185,237	1,981.49	284,484	723,179	4,176,730	9,753,596
Grand total.....		17,861,682	222,391.35	10,907,122	338,215,867	200,463,851	157,710,091

Class of material concentrated	Method of concentration	Concentrates produced		Gross content of concentrates				
		Class	Quantity	Gold	Silver	Copper	Lead	Zinc
Ore:	Flotation.	Sulphide copper.	Short tons 445,756	Fine ounces 104,292.12	Fine ounces 1,019,136	Pounds 281,077.725	Pounds	Pounds
	do.	Sulphide copper-lead.	1,399	202.38	10,929	558,378	2,863,897	
	do.	Oxidized lead.	4,614	1,425.42	73,429	790,420	16,457,572	
	do.	Sulphide and oxidized lead.	21,364	5,125.47	812,033	131,576	128,143,032	
	do.	Sulphide iron.	130,005	30,043.61	5,819,718	4,272,566	2,008,017	
	do.	Sulphide zinc.	56,058	5,994.52	133,010	254,320	2,849,429	
			83,718	4,991.36	468,554	781,453		89,479,394
Do.	Tables and flotation.	Sulphide lead.	742,914	152,074.88	8,336,809	287,866,498	152,351,967	89,479,394
	Tables.	Sulphide zinc.	32,317	2,123.36	651,950	272,841	23,564,835	
		Sulphide copper, sulphide lead, and oxidized lead.	14,334	139.40	13,371		68,277	15,767,074
			889	1,012.87	14,819	53,250	80,722	
Total from ore.			790,454	155,356.51	9,016,949	288,192,529	176,065,801	105,246,468
Old tailings:								
	Flotation.	Sulphide and oxidized lead.	714	98.57	23,392	11,655	620,945	
		Sulphide iron.	249	14.76	1,031	2,647	9,960	
		Sulphide zinc.	1,541	31.38	3,273	3,598	46,377	1,590,190
	Tables.	Sulphide lead.	51	5.44	375	835	16,018	
Total from old tailings.			2,555	150.15	28,071	18,735	693,300	1,590,190
Grand total.			793,009	155,506.66	9,045,020	288,211,264	176,759,101	106,836,658

For 1928, for the first time, exact figures on the contents of the mill ore in Utah were secured; they are presented in the accompanying tables. No individual mill recovery is disclosed except where permission to do so was obtained. The original feed to the mills—17,861,682 tons of all classes of ore and old tailings—contained 222,391.35 ounces of gold, 10,907,122 ounces of silver, 338,215,867 pounds of copper, 200,468,851 pounds of lead, and 157,710,091 pounds of zinc. The ore and old tailings were reduced to 793,009 tons of concentrates of all classes, an average ratio of concentration of 22.52:1. The concentrates contained 155,506.66 ounces of gold, 9,045,020 ounces of silver, 288,211,264 pounds of copper, 176,759,101 pounds of lead, and 106,836,658 pounds of zinc. The calculated recoveries are as follows: Gold, 69.92 per cent; silver, 82.93 per cent; copper, 85.22 per cent; lead, 88.17 per cent; and zinc, 67.87 per cent. The following table gives the metallurgical results of the treatment of Utah ores by flotation:

Metallurgical results obtained by flotation of Utah ores in 1928

Class of ore treated	Concentrate made	Ratio of concentration	Per cent recovered				
			Gold	Silver	Copper	Lead	Zinc
Sulphide copper.....	Sulphide copper.....	37.15:1	70.06	71.43	85.56	-----	-----
Sulphide copper-lead.....	{ do.....	32.16:1	6.82	9.31	33.54	-----	-----
	{ Sulphide copper-lead.....	9.75:1	48.00	62.53	47.48	90.08	-----
Total.....	-----	7.48:1	54.82	71.84	81.02	90.08	-----
Oxidized lead.....	Oxidized lead.....	2.63:1	64.23	77.68	51.54	90.52	-----
Sulphide lead-zinc.....	{ Sulphide and oxidized lead.....	6.73:1	53.78	81.89	64.82	88.64	-----
	{ Sulphide iron.....	15.61:1	10.73	1.87	3.86	1.39	-----
	{ Sulphide zinc.....	10.45:1	8.94	6.59	11.86	1.97	73.26
Total.....	-----	3.24:1	73.45	90.35	80.54	92.00	73.26
Grand total.....	-----	23.60:1	70.51	85.98	85.41	91.80	72.10

Mine production of metals from Utah concentrates in 1928

BY COUNTIES

	Ore and old tailings to concentrating mills		Concentrates and recovered metal					
	Ore	Old tailings	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Beaver.....	558	-----	478	3.33	3,822	1,493	166,897	240,812
Juab.....	16,575	-----	4,351	434.34	257,768	24,571	3,401,948	41,563
Salt Lake.....	17,092,914	289	623,912	124,629.41	2,724,570	275,418,458	79,528,132	44,510,260
Summit.....	191,102	180,000	44,115	3,328.91	2,545,547	964,807	30,951,574	11,917,602
Tooele.....	4,946	4,948	2,867	127.32	25,993	14,814	1,181,063	1,494,868
Utah.....	42,934	-----	17,908	5,707.14	562,351	121,751	12,303,050	-----
Wasatch.....	327,416	-----	99,378	21,276.21	2,924,969	1,105,516	40,032,081	35,652,247
Total, 1927..	17,676,445	185,237	793,009	155,506.66	9,045,020	277,651,410	167,564,745	93,857,352
	14,936,024	167,352	836,931	140,504.59	8,180,673	239,023,209	164,134,651	99,185,443

Mine production of metals from Utah concentrates in 1928—Continued

BY KINDS OF CONCENTRATES

	Concentrates and recovered metal					
	Concen- trates pro- duced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	56,781	6,062.47	136,887	167,029	1,917,078	-----
Copper.....	447,953	105,507.17	1,036,228	272,493,209	5,943	-----
Lead.....	184,068	37,349.46	7,313,278	3,739,130	160,430,924	-----
Zinc.....	99,593	5,162.14	485,198	619,706	2,461,597	93,857,352
Copper-lead.....	4,614	1,425.42	73,429	632,336	2,749,203	-----

Gross metal content of Utah crude ore shipped to smelters in 1928

Class of ore	Ore (dry weight)	Gross metal content			
		Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	157,951	21,623.04	2,096,966	1,945,793	9,147,822
Copper.....	70,257	9,859.49	250,383	4,902,532	600,789
Lead.....	283,036	21,547.45	5,411,420	2,935,317	124,322,508
Copper-lead.....	362	4.80	9,797	24,352	162,971
	511,606	53,034.78	7,768,566	9,807,994	134,234,090

Mine production of metals from Utah crude ore shipped to smelters in 1928

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Beaver.....	2,252	157.90	24,394	12,024	501,435
Box Elder.....	70	-----	67	85	31,385
Juab.....	107,760	8,782.93	1,870,463	1,324,902	15,445,809
Millard.....	223	-----	368	283	35,987
Piute.....	6,475	3,885.36	9,443	8,494	19,273
Salt Lake.....	160,368	16,360.69	1,037,876	6,201,086	25,569,168
Sanpete.....	13	-----	35	226	295
Summit.....	20,320	990.09	1,085,630	495,905	10,428,911
Tooele.....	38,822	3,640.43	247,775	152,329	13,592,354
Utah.....	170,697	18,825.34	3,351,060	708,677	56,255,097
Wasatch.....	4,605	382.83	141,452	63,028	1,352,774
Washington.....	1	9.21	3	-----	-----
Total, 1927.....	511,606	53,034.78	7,768,566	8,967,039	123,232,488
	530,545	44,817.72	9,665,925	10,847,075	135,758,350

BY KINDS OF ORE

		Gold	Silver	Copper	Lead
Dry and siliceous.....	157,951	21,623.04	2,096,966	1,885,727	4,678,902
Copper.....	70,257	9,859.49	250,383	4,739,661	311,568
Lead.....	283,036	21,547.45	5,411,420	2,322,169	118,087,195
Copper-lead.....	362	4.80	9,797	19,482	154,823

REVIEW BY COUNTIES AND DISTRICTS

BEAVER COUNTY

In 1928 six lode mines in Beaver County produced 2,810 tons of ore, yielding metals valued at \$75,237, a decrease from \$121,172 in 1927. This decrease was due chiefly to the fact that no shipments of old tailings were made from the Horn Silver dump. Mines of the Star district near Milford continued to produce lead ore, and the Horn Silver property at Frisco was worked by lessees.

Beaver Lake district.—Continuous development work was carried on at the property of the Beaver Copper Co., north of Milford, and manganese ore carrying silver was said to have been opened late in the year.

San Francisco district.—The Horn Silver mine was worked as usual by lessees who shipped about 1,000 tons of mixed ore, which was chiefly oxidized lead ore, and several hundred tons of lead-zinc ore, which was treated in the custom mill at International. The report to the industrial commission gave 1,491 tons of first-class ore and milling ore, containing 104 ounces of gold, 14,248 ounces of silver, 418,075 pounds of lead, and 260,000 pounds of zinc. Late in the year the property was taken over by the Tintic Lead Co., which began a systematic campaign of development early in 1929 to explore this famous old producer. The report of the Tintic Lead Co. for 1928 states that the holdings of the company include 4,173 acres in the San Francisco district, including the famous Horn Silver mine; 351 acres in the Beaver Lake district; 2,340 acres in the Star district (all in Beaver County); and 1,200 acres in the eastern part of the Tintic district (Utah County). Work was organized with the necessary supplies, machinery, and men to open the Horn Silver mine at depth and prospect virgin territory.

Star and North Star district.—Five lode mines in the Star district produced 1,268 tons of ore, which yielded \$949 in gold, 13,997 ounces of silver, 7,854 pounds of copper, 269,591 pounds of lead, and 10,792 pounds of zinc, valued in all at \$26,562, or \$20.95 in metals a ton. Nearly all the ore was shipped for smelting and consisted of oxidized silver-lead ore chiefly from the Moscow mine. This property, which is 8 miles southwest of Milford, was operated mainly on development, and the output decreased slightly. Two cars of lead-zinc ore also produced from the Moscow mine were treated in the custom flotation plant at Midvale. Ore was opened on the 1,400 and 1,500 foot levels, and shipments increased early in 1929. Several cars of lead ore were also shipped from the Magnolia, Beaver Crown, and Orphan Boy properties.

BOX ELDER COUNTY

The output from Box Elder County was unusually small in 1928; it consisted of 2 test lots of lead ore from the Clear Creek and Newfoundland districts and 2 cars of oxidized lead ore from the Lakeview mine in the Promontory district west of Ogden. Old mill machinery at the Vipont mine in the Ashbrook district, which produced considerable gold and silver as late as 1923, was sold. Development work was progressing at the Alvarado property 12 miles northeast of Ogden in the Sierra Madre district.

GARFIELD COUNTY

Imperial district.—A small quantity of placer gold was recovered by sluicing at the North Wash placer, in the Henry Mountains, south of Hanksville.

GRAND COUNTY

La Sal district.—The Utah Placer Co. operated the Big Six placer, at Dewey, on Colorado River, and deposited bullion valued at nearly \$600 at the Denver Mint.

JUAB COUNTY

Twenty-one lode mines in Juab County produced metals valued at \$3,036,754 in 1928, a marked decrease from \$5,658,891 in 1927. Most of the ore and old tailings came from mines and dumps near Eureka, mentioned in the review of the Tintic district. The decrease in the output of the Plutus, Chief Consolidated, Victoria (Bingham Mines Co.), Mammoth tailings dump, and Mammoth mines was large.

Detroit (Joy) district.—The Ibex Gold Mining Co. shipped two cars of oxidized copper ore containing considerable gold from Wilson on the Los Angeles & Salt Lake Railroad.

Fish Springs district.—The Galena and Utah properties were idle, but a test lot of silver-lead ore probably from the dumps was shipped to the smelter at Murray.

Spring Creek district.—The Boston property of the Premier Silver Mining Co., 10 miles south of Ibapah, was worked by lessees, who shipped one car of oxidized silver-lead ore to the lead plant at Murray.

Tintic district.—The production from the old mines near Eureka in the western part of the Tintic district in Juab County has decreased gradually in recent years, while the production in the eastern section of the Tintic district in Utah County has increased decidedly. The mines in both sections of the Tintic district are reviewed here, and their output is included in the following table.

Mine production of gold, silver, copper, lead, and zinc in Tintic district, Utah, 1927-28, and total, 1869-1928

	Mines pro- ducing	Ore and old tail- ings	Gold	Silver	Copper	Lead	Zinc	Total value
1928								
Juab County-----	18	<i>Short tons</i> 170, 394	\$266, 297	<i>Fine ounces</i> 2, 338, 572	<i>Pounds</i> 1, 742, 557	<i>Pounds</i> 19, 773, 460	<i>Pounds</i> 41, 563	\$3, 034, 686
Utah County-----	9	208, 955	444, 955	3, 894, 030	714, 339	68, 419, 131	-----	6, 794, 137
Total, 1927-----	27	1 379, 349	711, 252	6, 232, 602	2, 456, 896	88, 192, 591	41, 563	9, 828, 823
	31	2 446, 193	646, 049	7, 591, 406	3, 783, 431	90, 089, 355	1, 051, 534	11, 188, 934
Total, 1869-1928--	-----	(*)	39, 313, 139	211, 089, 809	210, 383, 618	1, 455, 450, 040	28, 984, 328	314, 585, 886

* Includes 46,142 tons of old tailings sold to a smelter.

† Includes 91,730 tons of old tailings sold to a smelter and 23,400 tons of old tailings treated in a volatilization plant.

‡ Figures not available.

NOTE.—Total dividends, 1869-1928, \$50,196,452.

The value of the metals from the Tintic district in 1928 was as follows: Gold, \$711,252, compared with \$646,049 in 1927; silver, \$3,646,072, compared with \$4,304,328; copper, \$353,793, compared with \$495,629; lead, \$5,115,171, compared with \$5,675,630; and zinc, \$2,535, compared with \$67,298. The ore and old tailings sold or

treated in the district in 1928 yielded on an average \$25.91 in metals a ton, compared with \$25.08 in 1927.

Mine production of gold, silver, copper, lead, and zinc in Tintic district, Utah, in 1928, by kinds of ore

Kind of ore	Mines producing	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc
		<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	23	¹ 168, 117	16, 504. 87	1, 906, 589	1, 645, 702	4, 338, 188	-----
Copper.....	2	2, 742	473. 59	45, 422	192, 296	9, 357	-----
Lead.....	17	208, 116	17, 425. 00	4, 278, 668	617, 823	83, 780, 685	-----
Lead-zinc.....	2	374	3. 34	1, 923	1, 075	64, 361	41, 563
	² 27	379, 349	34, 406. 80	6, 232, 602	2, 456, 896	88, 192, 591	41, 563

¹ Includes 46,142 tons of old tailings sold to a smelter.

² A mine producing more than one class of ore is counted but once in arriving at total for all classes.

There was a large decrease in the metals produced by the Chief Consolidated properties—the Chief, Grand Central, Gemini, and Eureka Hill mines. The Chief Consolidated flotation plant at Eureka was operated for 9 months, but the volatilization plant, formerly used on low-grade ore from the Eureka Lilly mine in the eastern part of the district and on low-grade tailings from the Eureka Hill dump, was practically idle. The total shipments of ore of the Chief Consolidated Mining Co., including 16,244 tons of mill ore, were reported as 58,734 tons in 1928, compared with 85,179 tons in 1927. This total includes ore from the property of the Plutus Mining Co., a separate incorporation controlled and worked by the Chief Consolidated Mining Co.; after transportation, sampling, and all operating charges were deducted the ore yielded a profit of \$162,223. A dividend amounting to \$114,286 was paid in February, 1928, making a total of \$3,654,519 paid since the first dividend of February, 1913.

The combined metal contents of the ores from the Chief Consolidated properties, including the output of the Plutus mine, are given as follows in the company's annual report. The totals do not represent recovered metals but are assay contents of ores milled and ores shipped for smelting.

Metal contents (assay) of crude smelting ore and mill ore from Chief Consolidated property and Plutus mine, 1927-28

Year	Ore	Gold	Silver	Copper	Lead	Zinc	Net returns	
							From smelter	After charges
	<i>Dry tons</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>		
1927.....	85, 179	6, 763	1, 950, 586	539, 998	21, 261, 426	1, 060, 663	\$1, 772, 707	\$233, 081
1928.....	58, 734	3, 846	1, 244, 844	472, 958	12, 163, 714	9, 822	1, 336, 058	162, 223

Of the 58,734 tons of ore produced from the Plutus and Chief Consolidated properties, 26,128 tons of silver-lead ore and 16,362 tons of dry and siliceous ore were shipped for smelting; the custom flotation plant at Midvale received 42 tons of lead-zinc ore; and the

concentrator at the Chief mine received 16,202 tons, of which 14,320 tons represented silver-lead ore and 1,882 tons dry gold and silver ore. These ores averaged as follows: Gold, \$1.34; silver, 21.19 ounces; lead in lead ores, 15.02 per cent; copper in copper ores, 1.39 per cent; lead in zinc-lead ores, 11.10 per cent; and zinc in zinc-lead ores, 11.80 per cent. All ores averaged \$28.27 a ton in total value, which, after \$12.62 was deducted for smelting, freight, and sampling, left a net value of \$15.65 a ton. The company did 5,178 feet of development (in drifts, raises, and winzes) in the Chief Consolidated properties—Nos. 1 and 5 shafts—as well as 8,280 feet of work in the Plutus mine, 2,706 feet in the Desert claim area (Tintic Bullion), and 270 feet of drifting in the Apex Standard area. The company received \$1,336,058 from the sale of ore, concentrates, lime, etc., and the costs were \$1,280,105, leaving a net operating profit of \$55,953. Other income amounting to \$200,930, chiefly from profits received from the subsidiary company (Plutus) and profit realized on stock previously held, brought the total income up to \$256,883. Miscellaneous expenses, including Federal and State taxes, amounted to \$94,660, leaving a net profit for the year of \$162,223. The net surplus on December 31, 1928, was \$3,355,738.

The output of the Chief, or No. 1 mine, is given for 1928 separately—12,698 tons of ore, 758 ounces of gold, 205,042 ounces of silver, 2,183,801 pounds of lead, and 9,822 pounds of zinc. The output of the Chief mine from 1909, the date of discovery, to 1928 was as follows: 1,200,481 tons of ore, 79,611 ounces of gold, 31,541,198 ounces of silver, 444,458 pounds of copper, 201,045,001 pounds of lead, 21,348,392 pounds of zinc, and 360,716 pounds of manganese. The Grand Central, or No. 5 mine, in 1928 produced 12,687 tons of ore, 1,754 ounces of gold, 228,258 ounces of silver, 258,008 pounds of copper, and 1,700,460 pounds of lead. Since the property was acquired by the Chief company in 1922 the Grand Central has produced 190,436 tons of ore, 51,859 ounces of gold, 2,809,187 ounces of silver, 6,018,588 pounds of copper, and 7,507,270 pounds of lead.

The Eagle & Blue Bell mine⁶ produced 20,324 dry tons of low-grade smelting ore, including 9,207 tons of dump ore, containing 2,140 ounces of gold, 161,992 ounces of silver, 1,863,892 pounds of lead, and 98,824 pounds of copper, for all of which the net smelter returns were \$100,548, compared with \$147,905 in 1927. The mine is opened by a vertical shaft 2,000 feet deep; 2,564 feet of development was done in 1928. The gross income from operations was \$115,109, operating expenses \$95,077, and development \$22,649. The net loss after receiving other income was \$1,661; no regular dividends were paid from the year's earnings. The company's report says:

The production from the Eagle & Blue Bell mine was less than in 1927. The ore was relatively low-grade and obtained largely from old stopes where showings of ore were followed.

The 1,875 level was advanced and several leads prospected. Bunches of shipping ore were disclosed, but the work failed to develop a profitable ore body. There are areas of unexplored ground at various horizons in the mine which warrant development.

The Victoria property of the Bingham Mines Co. adjoining the Eagle & Blue Bell mine, southeast of Eureka, was operated con-

⁶ Bingham Mines Co. Twentieth Ann. Rept., for year ended Dec. 31, 1928.

tinuously and produced 13,344 tons of smelting ore containing 938 ounces of gold, 316,038 ounces of silver, 2,634,856 pounds of lead, and 217,591 pounds of copper, for which the smelter paid \$206,312, compared with \$469,949 in 1927. About 3,200 feet of development was done in drifts, crosscuts, and raises. Half of the output was sulphide lead ore, about 38 per cent was siliceous silver ore, and the remainder was oxidized copper ore. The report of the Bingham Mines Co. for 1928 contains the following paragraph:

There was a marked decrease in shipments from the Victoria mine in the Tintic district, due to the depletion early in the year of the 135 and 373 ore bodies; but in July a new discovery was made from the 233 winze below the 1,300 level, and development work has recently disclosed ore on the 1,350 and 1,550 levels, so an improvement in output is expected.

The company did no work in the American Star property at Eureka.

The Tintic Standard and Iron Blossom mines⁷ produced 123,788 dry tons of ore containing 5,243.03 ounces of gold, 3,051,953 ounces of silver, 39,288,570 pounds of lead, 863,572 pounds of copper, and 2,479 pounds of bismuth, which sold for \$4,446,616, compared with \$4,984,293 in 1927. After smelter and freight charges of \$1,810,072 were deducted the net smelter returns amounted to \$2,636,544. Income from other sources amounted to \$286,048, which made a total income for the year of \$2,922,592. The mining cost amounted to \$1,001,984. Deduction of general administrative expense, \$103,929, annual depreciation of plant and equipment, \$46,870, and State, county, and Federal taxes, \$275,874, left a net income carried to surplus account of \$1,493,935. On December 31 the total current assets of the company were \$3,920,123. Dividends of \$1,614,631 were paid in 1928, making a total of \$11,057,255 to date. The lead ore, 68,435 tons, contained on the average 0.041 ounce of gold and 29.80 ounces of silver to the ton, 0.31 per cent of copper, and 24.84 per cent of lead. The dry silver ore shipped, 93 tons, contained on the average 0.29 ounce of gold and 582.35 ounces of silver to the ton, 1.82 per cent of copper, and 3.62 per cent of lead. The siliceous ore, 55,260 tons, contained on the average 0.044 ounce of gold and 17.35 ounces of silver to the ton, 0.40 per cent of copper, and 4.78 per cent of lead. The company's report gives no details regarding ore reserves; it gives the output of the Tintic Standard mine to date—the ore shipped or milled with metal content—as follows: 1,247,895 tons of ore, 44,287.04 ounces of gold, 32,415,354 ounces of silver, 9,747,152 pounds of copper, and 327,483,155 pounds of lead. The report continues:

In the year 1928 the company enjoyed a prosperous year, though, you will notice, the output of metals was less. A reduction in output was decided upon in June when it became evident that the production of lead was greater than the demand and rapid declines in price were taking place.

At the Tintic Standard mine development work to the extent of 5,870 feet of drifting and 1,004 feet of raising was carried on during the year. Work was continued on the 800, 900, 1,000, 1,250, and 1,350 levels with satisfactory results.

The Empire Mines Co. shipped about 2,000 tons of siliceous gold and silver ore containing a little copper and lead from the dump.

⁷ Tintic Standard Mining Co. Ann. Rept. for year ended Dec. 31, 1928.

The report to the industrial commission gave 2,079 tons of ore, containing 416 ounces of gold, 15,911 ounces of silver, 14,009 pounds of copper, and 53,566 pounds of lead.

The Bullion Beck & Champion property, controlled by the United States Smelting, Refining & Mining Co., was not worked in 1928, but several thousand tons of old tailings and low-grade ore left from former operations were shipped. Preliminary work, including the installation of a new compressor, headframe, electric hoist, and construction of surface buildings, was done during the latter part of the year preparatory to reopening the mine.

Lessees operating the Centennial Eureka property shipped several hundred tons of dump ore containing chiefly silver.

No regular development was done at the Gold Chain mine in 1928, but about 900 tons of oxidized copper ore was shipped by lessees.

The Iron Blossom mine near Silver City, now controlled and operated by the Tintic Standard Mining Co., produced nearly 6,000 tons of siliceous silver ore and oxidized lead ore. The property has been a large producer since 1909 and was purchased by the Tintic Standard Mining Co. in 1925. The production, chiefly silver and lead, is included in the statement of the Tintic Standard Mining Co. (See p. 502.) The siliceous ore contained an oxidized bismuth mineral, and the company was paid for 2,479 pounds of bismuth. The output of the Iron Blossom mine to date is as follows: 569,360 tons of ore, 92,314.39 ounces of gold, 14,990,439 ounces of silver, 6,931,686 pounds of copper, 61,606,344 pounds of lead, and 12,489 pounds of bismuth.

The Plutus mine, controlled and operated by the Chief Consolidated Mining Co., produced 32,936 tons of oxidized silver-lead ore containing 1,301 ounces of gold, 805,585 ounces of silver, 196,341 pounds of copper, and 8,221,511 pounds of lead. This production was a decrease from 42,280 tons in 1927. The Plutus mine was the eighth largest producer of silver and the ninth largest producer of lead in Utah in 1928. The company received \$586,615 from the sale of ore and paid \$99,715 in dividends. Since the controlling interest in the Plutus mine was acquired by the Chief Consolidated Mining Co. in 1923 the property has produced 125,272 tons of ore, 5,019 ounces of gold, 3,593,102 ounces of silver, 1,042,707 pounds of copper, and 34,084,477 pounds of lead, for which the smelters paid \$2,927,604. The following paragraph is taken from the report of the operating company, the Chief Consolidated Mining Co.

The new find made some time ago on the north end of the Plutus property has at the time of this writing developed extension and quality in a quite encouraging way and in the southern workings of this property similar results have followed an ore find there with the result that the Plutus is now again making some profit. This condition will permit of added development work and this in turn may and likely will add to further finds of new ore and resulting resumption of former profit.

The Mammoth Mining Co. continued to operate its property near Mammoth, south of Eureka, and shipped nearly 15,000 tons of mixed ore, chiefly siliceous silver ore containing gold and copper. No dividends were paid in 1928, and the output decreased from approximately 26,000 tons of similar material in 1927. The report to the industrial commission gave 14,685 tons of ore containing 738 ounces

of gold, 295,335 ounces of silver, 415,072 pounds of copper, and 649,544 pounds of lead; the net proceeds were only \$8,614.

The American Smelting & Refining Co. continued to ship old tailings from the Mammoth dump. The material contains gold, silver, and copper and is chiefly valuable for its gold and silver; it is used as siliceous flux at the copper smelter at Garfield.

Shipments of old tailings were continued from the Eureka Hill dump at Eureka, owned and operated by the Chief Consolidated Mining Co. In 1928 practically all this material was shipped for smelting, whereas in 1927 a large portion of it was treated in the fuming plant adjoining the Chief Consolidated flotation plant at Eureka.

Other producers in the Juab County part of the Tintic district in 1928 were the Dragon and Swansea properties, and a clean-up was made around the ore bins of the old Tintic Milling Co.

The chief producers in the eastern part of the Tintic district in Utah County were the Tintic Standard (for review, see p. 502), North Lily, Eureka Lilly, Eureka Standard, Colorado Consolidated, Mountain View, and Yankee Consolidated properties. An interesting feature in this section was the marked increase in the output of the North Lily mine. Oxidized silver-lead ore—nearly 50,000 tons, or an increase from 21,485 tons in 1927—was shipped to the lead smelter and concentration plant at International. Development work, aggregating 7,281 feet, was done chiefly in drifts and raises, and the 4-compartment shaft was sunk 518 feet. The chief ore mineral is anglesite, but late in 1928 and in 1929 much sulphide ore was being mined. According to the printed annual report of the Anaconda Copper Mining Co. the North Lily mine produced during the year 49,962 tons of lead ore, which yielded 6,352 ounces of gold, 729,154 ounces of silver, and 23,683,375 pounds of lead. The construction of an aerial tramway nearly 4,000 feet long was completed early in the year to deliver the ore from the shaft to the railway siding. Regular shipments of silver-lead ore were made, and the company paid its first dividend of \$159,110 in September. The mine was the fifth largest producer of lead in Utah in 1928 and seventh in the output of gold and silver. The following paragraphs are taken from the company's fiscal report for the year ended September 20, 1928:

Early in 1924 the International Smelting Co. acquired by purchase a majority of the stock of the North Lily Mining Co., after an exhaustive geological study of the Tintic district. Through this connection with the smelting company this company was enabled to secure competent geological direction and to finance a diamond drilling campaign and subsequent development without assessments upon the stockholders. Five drill holes were sunk from the surface which disclosed the presence of the favorable Ophir limestone above the quartzite and below the rhyolite flow which entirely covers the surface of the property.

In 1926 the company was able to make an arrangement with the Tintic Standard Mining Co. whereby all the facilities of that big organization were made available to the North Lily Mining Co. In 1927 the first ore was cut in the 700 drift from the Tintic Standard mine, approximately 170 feet after crossing the North Lily sideline. Ore shipments began at once and the company since that time has been self-supporting. During the first year after ore was discovered the principal production came from between the 700 level and the 600 level.

While the mining of this ore was going on, the 900 drift from the Tintic Standard mine was run into the North Lily property and connected with the

700 level by means of a raise. A four-compartment shaft was sunk from the surface, and the 600, 650, 750, 800, and 850 levels were opened, all showing ore. Late in June, 1928, the new shaft was completed. The tramway and other surface equipment were ready for operation and the North Lily Mining Co. began mining operations through its own shaft. The first bucket of ore was sent over the tramway on May 19, 1928.

During the last three months, July, August, and September, the period that North Lily has been operating through its own shaft, the production of ore has been 18,372 tons, or an average of more than 6,000 tons per month, with a corresponding operating profit of \$361,607, or exceeding \$120,000 per month.

The Eureka Lilly Mining Co., controlled by the Chief Consolidated Mining Co., produced 23,117 dry tons of silver-lead ore, most of which was concentrated. The ore contained 8,821 ounces of gold, 191,859 ounces of silver, and 6,614,955 pounds of lead. The net smelter returns were \$351,292, and after deducting various charges the net profit was \$114,617. The output represents an increase from 6,360 tons in 1927 containing 1,372 ounces of gold, 47,717 ounces of silver, and 2,254,414 pounds of lead. The report of the Chief Consolidated Mining Co. for 1928 says:

The Eureka Lilly mine produced a fair tonnage of ore; it is expected that this ore will make in larger and richer deposits at depth. Development of this lower area will be started on the completion of the North Lily shaft which is now in progress.

The mine has not as yet developed any of the rich ore found by the Tintic Standard or North Lily mines flanking it on either side.

The Eureka Standard mine, south of the Tintic Standard property and controlled by the Tintic Standard Mining Co., produced 4,296 tons of siliceous gold ore containing 3,284.75 ounces of gold, 45,440 ounces of silver, 13,789 pounds of copper, and 49,931 pounds of lead. Ore of commercial value was discovered and shipments began June 1, 1928. The mine is opened by a vertical shaft 1,600 feet deep.

At the Eureka Standard mine, on the 1,100 level, we have developed an ore body that is of great importance. The ore was found in the Cambrian quartzite underlying the limestone beds from which our ores have heretofore been mined and is in the footwall side of the Eureka Standard fault. By December 31, 1928, the ore body had been developed for 450 feet on its strike and it extends from the 1,000 level to the 1,220 level. The average width above the 1,100 level is approximately 6 feet and is the same below that level so far as limited development shows. The ore contained an average of 0.7694 ounces gold and 10.5778 ounces silver.

The Colorado Consolidated property, controlled by the Tintic Standard Mining Co., shipped from Silver City 10,919 tons of mixed ore containing 702.18 ounces of gold, 42,882 ounces of silver, 22,854 pounds of copper, and 660,331 pounds of lead. The output was chiefly siliceous silver ore containing gold, copper, and lead. More than \$57,000 was spent in development on the 1,900-foot level and in exploring this old producer.

The Iron King mine, southwest of Dividend, was operated by the Tintic Standard Mining Co. chiefly for development. Two lots of ore containing mainly gold and silver were shipped for smelting. Development consisted of 1,367 feet of drifting and 182 feet of shaft sinking. A new fissure is being prospected from the 1,550-foot level.

The Uncle Sam and May Day properties, east of Eureka, owned by the Mountain View Mining Co., were worked by lessees, who shipped about 1,200 tons of siliceous gold ore and oxidized lead ore.

The Yankee property, south of Knightsville, was worked by lessees who shipped several hundred tons of material, chiefly oxidized silver-lead ore.

Several cars of siliceous silver ore were shipped from the dump of the Utah Consolidated property, also near Knightsville. Considerable development was done at the Crown Point, East Standard, Tintic Giant, North Standard, Tintic Coalition, North Beck, Silver Shield, and other properties, which produced no ore that was marketed.

MILLARD COUNTY

Kanosh district.—The Blue Bell property, owned by the M. M. Lead Co., produced several cars of oxidized lead ore that was shipped to the lead plant at Murray.

MORGAN COUNTY

The Morgan Chief mine, 8 miles from Peterson, in the Argenta district, was being developed, and preparations were made for shipping ore in 1929.

PIUTE COUNTY

Mount Baldy district.—The Deer Trail property, southwest of Marysvale, formerly a large producer of gold, was worked under lease by the United States Smelting, Refining & Mining Exploration Co. Besides the exploration work done, the company shipped more than 6,000 tons of ore that was chiefly valuable for its gold. Early in 1929 the lease was relinquished, and the property was again operated by the Deer Trail Mining Co. The old milling plant on the property, equipped for concentration and cyanidation, was not used.

Ohio district.—A small lot of gold-silver ore was shipped from the Gold Strike group or Krotki property and one car of silver-lead ore from the Bully Boy mine.

SALT LAKE COUNTY

Salt Lake County, chiefly the Bingham district, has been the most important mining center of Utah since 1905. The value of the metal output of the county in 1928 was \$55,374,507, or nearly 70 per cent of the value of the State output. The increase in the price of copper in 1928 resulted in a large increase in the value of the output of copper, gold, and silver, although there was a decrease in the output of lead and zinc.

The mines of Bingham have been large producers since the early days of mining. Their output increased decidedly after the Utah Copper Co. started steam-shovel mining in 1907, and the value of the county's metal output in 1928 was more than four times that in 1907.

Big and Little Cottonwood districts.—The production of the mines at Alta, the head of Little Cottonwood Canyon, and of those in Big Cottonwood Canyon has been combined in the following table.

Mine production of gold, silver, copper, lead, and zinc in Big Cottonwood and Little Cottonwood mining districts, Utah, 1927-28, and total, 1867-1928

Year	Mines producing	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
		<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1927-----	11.	5, 181	\$5, 085	148, 115	249, 337	2, 017, 283	1, 666	\$248, 925
1928-----	9	1, 518	2, 839	30, 846	139, 489	292, 975	-----	57, 963
Total, 1867-1928-----		603, 064	566, 251	16, 390, 698	15, 747, 198	231, 121, 184	683, 991	33, 248, 471

In the Big Cottonwood district five lode mines produced 635 tons of ore, which yielded \$153 in gold, 19,047 ounces of silver, 21,043 pounds of copper, and 221,001 pounds of lead, valued in all at \$27,144, or \$42.75 in metals a ton. The chief producers were the Cardiff and Prince of Wales mines. The output of the Cardiff mine was unusually small in 1928, consisting of 355 tons of copper-lead ore as compared with 3,000 tons marketed in 1927. The company paid no dividends in 1928. Early in 1929 a series of snowslides completely destroyed the compressor-plant building at the mouth of the main haulage tunnel. Important development was done at the Cottonwood King, Baby McKee (Howell), Tar Baby, and Kentucky-Utah properties, near the old Maxfield mine, and at the Utah Copper Queen property, at the mouth of the canyon.

The Alta Tunnel & Transportation Co. operated a 50-ton concentration plant equipped with jigs and tables at the Prince of Wales property, 18 miles east of Murray, and milling operations became more regular early in 1929. Only small lots of ore were shipped from the Maxfield and Lake Blanche properties.

In the Little Cottonwood district 4 lode mines produced 883 tons of first-class shipping ore, which yielded \$2,686 in gold, 11,799 ounces of silver, 118,446 pounds of copper, and 71,974 pounds of lead, valued in all at \$30,819, or \$34.90 in metals a ton; the output of ore in 1927 was 1,815 tons. The Columbus & Flagstaff property, operated by the Mineral Veins Coalition Mines Co., was the largest producer in the vicinity of Alta. Shipments consisted of mixed copper ore and lead ore. The report to the industrial commission gave 721 tons of ore containing 33 ounces of gold, 9,801 ounces of silver, 110,923 pounds of copper, and 30,367 pounds of lead. The Dipper group, on the north side of Little Cottonwood Canyon, 5 miles east of Sandy, was operated by the Clementine Mining Co., which marketed 7 small lots of sulphide iron ore containing gold. One of the lots assayed more than 10 ounces of gold to the ton. A car of ore was shipped from the Columbus Rexall mine and a small lot from the Louise property.

Bingham or West Mountain district.—In 1928 the mines of the Bingham district produced ore yielding on the average \$3.16 in metals a ton, compared with \$3.22 a ton in 1927. Shipments of first-class ore amounted to 159,052 tons, compared with 133,909 tons in 1927; the output of concentrating ore was 17,092,654 tons, compared with 14,385,212 tons in 1927; and the quantity of concentrates produced was 623,722 tons, compared with 677,689 tons

in 1927. The ore of smelting grade, amounting to 159,052 tons, consisted chiefly of copper and lead sulphides and a little siliceous gold ore; it yielded 16,211.77 ounces of gold, 1,014,359 ounces of silver, 6,062,285 pounds of copper, and 25,325,422 pounds of lead, valued in all at \$3,270,370, or \$20.56 a ton. The milling ore (17,092,654 tons) produced 623,722 tons of copper, lead, zinc, iron, and copper-lead concentrates, yielding 124,602.16 ounces of gold, 2,714,583 ounces of silver, 275,414,888 pounds of copper, 79,425,240 pounds of lead, and 44,492,643 pounds of zinc, valued in all at \$51,144,245, or \$82 in metals to a ton of concentrates. In addition, copper precipitates, recovered from mine water and from leaching of ore in place, yielded 6,207,777 pounds of copper valued at \$893,920.

Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Utah, 1927-28, and total, 1865-1928

Year	Mines producing	Ore	Gold	Silver	Copper ¹	Lead	Zinc	Total value
		<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1927-----	6	20 14, 519, 121	\$2, 566, 718	² 3, 582, 084	³ 249, 918, 989	111, 015, 187	49, 097, 827	\$47, 473, 366
1928-----	10	20 17, 251, 706	2, 910, 882	3, 728, 942	³ 287, 684, 950	104, 750, 662	44, 492, 643	55, 308, 535
Total, 1865-1928-----		(⁴)	⁵ 52,446, 394	⁵ 75,219, 702	3, 683, 379, 895	1, 864, 238, 414	240, 445, 487	\$45, 889, 351

¹ Includes copper saved from precipitates.

² Includes 21 ounces of silver and 6,046,915 pounds of copper saved from precipitates.

³ Includes 6,207,777 pounds of copper saved from precipitates.

⁴ Figures not available.

⁵ Includes placer production.

NOTE.—Total dividends, 1865-1928, \$184,050,063.

Mine production of gold, silver, copper, lead, and zinc in Bingham or West Mountain district, Utah, in 1928, by kinds of ore

Kind of ore	Mines producing	Ore	Gold	Silver	Copper	Lead	Zinc
		<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous..	6	24, 012	4, 392. 76	224, 201	590, 411	1, 161, 931	-----
Copper-----	10	16, 623, 818	111, 647. 41	1, 206, 163	¹ 282, 478, 955	253, 500	-----
Lead-----	16	69, 722	4, 463. 72	603, 131	1, 111, 641	23, 909, 991	-----
Copper-lead-----	1	44, 993	1, 627. 80	84, 358	1, 173, 963	2, 749, 203	-----
Lead-zinc-----	14	489, 161	18, 682. 24	1, 611, 089	2, 329, 980	76, 676, 037	44, 492, 643
	² 20	17, 251, 706	140, 813. 93	3, 728, 942	287, 684, 950	104, 750, 662	44, 492, 643

¹ Includes 6,207,777 pounds of copper saved from precipitates.

² A mine producing more than one class of ore is counted but once in arriving at total for all classes.

During 1928 the Utah Copper Co.,⁸ according to its annual statement, produced 16,558,500 tons of copper ore that contained 0.992 per cent of copper, or 19.84 pounds a ton. This ore was mined by electric shovels and treated at the Magna and Arthur flotation plants. Metals recovered from concentrates during 1928, together with 1,976,851 pounds of copper precipitated from mine waters, amounted to 273,823,351 pounds of copper, 917,226 ounces of silver, and 104,292.12

⁸ Utah Copper Co. Twenty-fourth Ann. Rept., for year ended Dec. 31, 1928.

ounces of gold, valued in all at \$44,019,605. The mine also produced 46,512 tons of lead-zinc ore, copper ore, and lead ore, partly through the operations of lessees. The copper concentrate shipped to the smelter averaged 31.53 per cent of copper in 1928, compared with 25.10 per cent in 1927.

After all operating charges of production, including the cost of marketing refined copper, were deducted the direct profits from mining operations for the year were \$24,433,051, compared with \$13,718,088 in 1927. Indirect earnings for the period, accruing as miscellaneous income incident to operations, amounted to \$4,167,314, which made a total income of \$28,600,365. The audit report shows deductions for other charges, including Federal income-tax accruals, depreciation of plant and equipment, and obsolescence or retirement of property, aggregating \$3,724,119, leaving a net income carried to surplus account of \$24,876,246, or approximately \$15.31 per share of capital stock outstanding.

Dividends paid to stockholders in 1928 amounted to \$8 a share, or a total of \$12,995,920. The aggregate distributions paid to stockholders up to December 31, 1928, were \$169,991,302, or \$104.64 a share of present outstanding capital stock. A revised calculation of developed ore reserves on December 31, 1928, as they will be mined, gave 625,000,000 tons of milling ore averaging approximately 1.066 per cent of copper. The total ore mined to date was 176,144,651 tons. Therefore, the total ore mined and to be mined from the beginning of mining to the exhaustion of the estimated reserves approximates 800,000,000 tons. A short article⁹ on the mine was published in August, 1927.

The mining cost for a ton of ore milled, including a proper apportionment of fixed and general charges (but not including Federal taxes and depreciation), was 31.78 cents, of which 16.19 cents represents stripping charges. This amount covered the cost of all stripping actually removed during the year and an apportionment of similar charges, previously deferred. The actual direct mining cost of all ore was 15.59 cents a ton, of which 11.73 cents represents all mine charges; the balance, or 3.86 cents, represents overhead expense.

The ore treated at the Magna and Arthur plants was 16,558,500 tons, about equally divided between the two mills and equivalent to a daily average of 45,742 tons. The average content of the ore was 0.992 per cent of copper, as compared with 0.98 per cent in 1927; the average recovery in the form of concentrates was 85.56 per cent, as compared with 89.12 per cent in 1927. The average milling cost was 36.9 cents a ton, a decrease of 8.33 cents from the cost of 1927.

The average cost per net pound of copper, including depreciation of plant and equipment and all fixed and general expenses (except Federal taxes) and after crediting gold, silver, and miscellaneous earnings, was 6.38 cents, compared with 7.54 cents, computed on the same basis, for 1927. The value of the gold and silver recovered and the miscellaneous earnings amounted to 1.22 cents per pound

⁹ Engineering and Mining Journal, Utah, Premier Copper Mine: Vol. 124, Aug. 20, 1927, p. 281.

of copper, as compared with 1.16 cents for 1927. The report continues:

Three churn drill holes were completed during the year and active work continued on three others, the aggregate depth drilled amounting to 5,101 feet. This work is being done in the northerly and westerly portions of the property. Improvements in operating methods and metallurgy and consequent reductions in costs during recent years have made it possible to add to the ore reserves, heretofore recorded, ore of a lower copper content. * * *

During the year stripping operations were carried on at a rate necessary to keep the proper tonnage of ore available for mining and 7,220,034 cubic yards of overburden with excavated and disposed of. Of this, 286,878 cubic yards was handled by contractors and the balance on company account. * * *

The yardage of capping, converted into terms of tons, together with the ore mined and shipped to the reduction plants at Garfield, correspond to a total quantity of material mined of 31,864,335 tons, equivalent to an average of 88,023 tons per operating day.

As in recent years, and as will be the case in the next few years, mining operations were most active on upper levels of the ore body where the grade of ore is below average. It is necessary to continue operations in this way in order to control the slopes of open pits and establish and maintain conditions best adapted to safety and economy in the removal of lower lying and better grade portions of the ore body. This necessity is emphasized in consideration of the fact that the elevation of the uppermost mining operations is 1,700 feet above the present base level of shovel pits and that eventually it will be necessary to mine ore at least 1,000 feet below the floor of the existing excavation.

Underground operations in the limestones in the southwestern portion of the property have progressed in a very satisfactory manner and during the year 46,512 dry tons of copper and lead ores were shipped from this source. Recent developments have indicated a very considerable tonnage of this class of ore.

In the last annual report mention was made of the fact that the capping removed since inception of operations and deposited on surface adjoining the mine had oxidized to a point where meteoric waters were dissolving a very appreciable amount of copper. These percolating waters average about 15 pounds of copper per thousand gallons. There was leached in this way during the year and deposited in improvised precipitating plants 1,933,235 net pounds of copper at a cost of 6.2 cents per pound. Profiting by this experience, a large central precipitating plant has been erected at a point low enough to receive all such waters carrying copper in solution that are not tributary to the smaller plants.

In connection with this it is interesting to realize that the large yardage of capping, formerly rejected as worthless, now promises a copper production of approximately one billion pounds—assuming a 70 per cent recovery as probable.

Improvements during the year reflected in the main a continuance toward completely supplanting steam power by electric energy. As a result, eleven 85-ton electric locomotives were substituted for a like number of steam locomotives and during the coming year all steam locomotives will be so replaced. In order to furnish power for this haulage system, four 1,000-kilowatt rotary converters with necessary transformers and switching apparatus were installed.

In furtherance of the policy of providing improved housing facilities for employees, 26 new houses were erected at the company's new town site at Copperton. This development, which is being continued, has proven highly beneficial to employees, their families, and to the working organization collectively.

When during the year the market demand for copper increased sharply it became profitable to sacrifice some mill recovery in the interest of larger metal output. The mills had an efficient capacity of 45,000 to 50,000 tons per day in company with recoveries of copper up to 90 per cent, both tonnage and recovery factors depending somewhat on character and grade of ore. It was found economically advantageous in the last quarter of the year to increase to about 60,000 tons per day, which resulted in lower mill recoveries because the fine grinding equipment was inadequate to reduce so large a tonnage to proper fineness for subsequent treatment. During the coming year additional fine grinding and accessory equipment will be installed to make the capacity of this department 60,000 tons per day in company with the metallurgical efficiency of the year 1927.

From 1918 to 1928 the company treated 108,923,951 tons of ore and produced 934,631 tons of net copper. As in 1927, both the Magna and Arthur mills were operated as flotation plants using an alkaline circuit. The grade of the copper concentrate is improved and the cost of smelting is reduced by dropping a large part of the pyrite at both mills. The concentrate consisted chiefly of primary chalcopyrite, whereas the concentrate formerly made by the old wet concentration plants was largely chalcocite from the enriched area.

The output from the United States Smelting, Refining & Mining Co.'s mines¹⁰ at Bingham, including the Niagara property, amounted to about 188,000 tons of ore, a decrease of 13,000 tons from that of 1927. With the exception of a little more than 4,600 tons, the entire output was lead-zinc ore treated at the new flotation plant at Midvale, which separates the galena-sphalerite-pyrite ore into lead, zinc, and iron concentrates. Both the lead and the iron products were treated locally at the Midvale lead smelter, and the zinc concentrate was shipped to Anaconda and Great Falls, Mont. Direct smelting ore consisted of several thousand tons of first-class lead ore and copper ore. The property ranked second in the production of zinc, fourth in lead, and third in gold in Utah in 1928. The Old Jordan-Telegraph-Last Chance group and the Niagara mine are opened at depth through the Niagara and Butterfield tunnels. In the former property approximately 13,000 feet of drifting, raising, and sinking was done in 1928, and in the Niagara mine 528 feet of raising and nearly 3,000 feet of drifting were done.

Details regarding production and the developed ore reserves are not published in the company's printed annual report, but the statement given to the industrial commission credited the main group with an output of 182,334 tons of first-class and milling ore containing 12,488 ounces of gold, 806,894 ounces of silver, 1,069,421 pounds of copper, 36,832,786 pounds of lead, and 33,193,318 pounds of zinc. The Niagara Mining & Smelting Co., controlled by the United States Smelting, Refining & Mining Co., reported to the industrial commission the shipment and treatment of 6,224 tons of ore containing 1,344 ounces of gold, 62,311 ounces of silver, 307,099 pounds of copper, 739,749 pounds of lead, and 378,519 pounds of zinc. It should be noted that the published figures do not represent the contents of the concentrates made; they represent the contents of both the first-class ore and the milling ore, chiefly the latter.

The Utah-Delaware Mining Co. worked the Highland Boy and Yampa groups at the head of Carr Fork and produced 170,762 tons of ore, a decrease of 28,191 tons from the output of 1927. The ore was mainly lead-zinc-iron ore treated at the custom flotation plant at International. About 25 per cent of the mine output was first-class copper ore and lead ore smelted at the copper and lead plants at International. An aerial tramway takes the ore, as well as some custom material from Bingham, to the International mill and smelter. The property ranked fourth in the production of copper and gold, fifth in zinc, and sixth in lead in Utah in 1928. The mine is extensively developed, and in 1928 the work consisted of

¹⁰ United States Smelting, Refining & Mining Co. Twenty-third Ann. Rept., for year ended Dec. 31, 1928.

7,367 feet of drifting, 3,222 feet of crosscuts, and 3,827 feet of raises. According to the printed report of the Anaconda Copper Mining Co., the Utah-Delaware mine produced 32,985 tons of copper ore and 137,777 tons of lead-zinc-iron ore. Most of the copper ore was produced by lessees, whereas the greater part of the lead-zinc ore was mined on company account. Details regarding ore reserves and costs are not made public. The contents of the smelting ore and the milling ore from the Utah-Delaware mine as reported to the industrial commission were 10,282 ounces of gold, 496,577 ounces of silver, 2,999,185 pounds of copper, 27,137,426 pounds of lead, and 11,056,881 pounds of zinc. This output is a marked decrease compared with that of 1927, when the property produced 198,952 tons of ore containing 11,254 ounces of gold, 687,246 ounces of silver, 3,873,909 pounds of copper, 38,725,642 pounds of lead, and 17,483,396 pounds of zinc.

The mine and mill of the Utah-Apex Mining Co. were operated the entire year, and the company paid a dividend of \$132,050. The output of first-class smelting ore decreased nearly 17 per cent in 1928 and the milling product about 15 per cent. The largest decrease was in copper-lead ore milled. The milling product consisted of lead-zinc ore that was reduced to lead concentrate and zinc concentrate and copper-lead ore that was reduced to copper concentrate, lead concentrate, and copper-lead concentrate. The crude smelting ore was chiefly sulphide copper ore of good grade. According to a report to the Bureau of Mines for the calendar year 1928, the company produced 193,570 tons of ore. Of this output 29,414 tons was shipped direct to the smelters, and 164,156 tons—of which 119,163 tons was lead-zinc ore and the remainder was copper-lead ore—was milled. The copper concentrate, 1,399 tons, contained 202.38 ounces of gold, 10,929 ounces of silver, and 558,378 pounds of copper. The lead concentrate, 15,943 tons, contained 2,350.49 ounces of gold, 291,269 ounces of silver, 962,838 pounds of copper, and 18,796,177 pounds of lead. The zinc concentrate, 10,301 tons, contained 323.42 ounces of gold, 21,422 ounces of silver, 237,339 pounds of copper, 403,465 pounds of lead, and 10,452,172 pounds of zinc. The copper-lead concentrate, 3,086 tons, contained 930.96 ounces of gold, 39,653 ounces of silver, 611,214 pounds of copper, and 1,493,296 pounds of lead.

The first-class smelting ore consisted of 25,561 tons of sulphide copper ore (containing 2,236.49 ounces of gold, 70,476 ounces of silver, and 2,197,534 pounds of copper) and 3,853 tons of sulphide lead ore (containing 166.40 ounces of gold, 22,458 ounces of silver, 103,154 pounds of copper, and 1,426,177 pounds of lead). The company reported to the Industrial Commission a total of 193,538 tons of ore extracted and gave the contents of the crude ore and concentrates shipped as 6,209 ounces of gold, 456,167 ounces of silver, 4,668,875 pounds of copper, 22,118,979 pounds of lead, and 12,379,131 pounds of zinc. The company ranked second in the production of copper in 1928, third in zinc, sixth in gold, and seventh in lead. The mine is developed by a main vertical shaft 2,400 feet deep, a winze 800 feet deep, and various drifts, raises, and tunnels. In 1928 development consisted of 22,000 feet of drifting and raising. The improved

flotation plant in Carr Fork, near Bingham, has a capacity of 700 tons of ore a day but treated only 456 tons a day; the ore contains chiefly sphalerite, chalcopyrite, galena, and bornite. The following notes are taken from the company's report for the fiscal year ended August 31, 1928:

Notwithstanding the low metal prices which prevailed throughout the greater part of the fiscal year, the management succeeded, by the strictest economy, in reducing the cost of mining ore by 76 cents per ton as compared with the previous year.

During the past year 22,034 feet of development work was done, approximately 3,600 feet more than in 1926-27. An extensive diamond drilling campaign was carried on in lateral exploration of virgin territory.

On the 2,700 level four ore bodies have been developed and are now being mined in the eastern portion of the Yampa limestone, but the grade of ore found in these channels is not as good as that in the same channels on the 2,500 level, nor is the horizontal cross section of the ore bodies quite so large. The larger ore bodies which were found on the 2,400 and 2,500 levels in the Leadville fissure zone have not yet been found to extend to the 2,700 level.

In the development of the lower workings the 2,400-50 winze has been extended to the 2,900 level, and at the present time drifts are being driven on this lowest level into the various ore channels of the Yampa limestone. * * *

The most important source of ore at the present time is the western part of the Yampa limestone, where it is crossed by the West Leadville fissure zone. This ore has been developed and is being mined from the 1,300 to the 1,600 level.

Our ore reserves are estimated as follows: 13,000 tons of copper ore, 39,000 tons of copper-lead ore, and 112,000 tons of lead-zinc ore.

Our present exploration and development campaign entails \$25,000 a month and more, under the direction of the best obtainable geologists' advice.

For the fiscal year ended August 31, 1928, the company received \$1,884,975 from the sale of ore, from royalties, etc. Mining, milling, and development cost \$1,455,186; after general expenses were paid a balance of \$65,316 was left before providing for depletion and the Federal income tax.

The Bingham Mines Co.¹¹ continued to operate the Dalton & Lark group at Lark, but lessees worked the company's Commercial mine at Bingham. The output of the Commercial mine was comparatively small and consisted of 337 tons of oxidized copper ore of smelting grade, 168 tons of sulphide lead ore, and 34 tons of lead-zinc ore. The Dalton & Lark property, which was being extensively developed on the dip and strike of its three producing veins, produced 44,879 tons of material, including lease ore, which was chiefly sulphide lead ore; about 600 tons of the output was lead-zinc ore shipped to International for milling. The property at Lark, which has been producing regularly since 1901, is extensively developed; 4,768 feet of work in drifts, crosscuts, raises, and winzes was done in 1928. The company paid \$175,000 in dividends in 1928 from the profits of its operations at Lark, Bingham, and Eureka, or a total of \$1,367,375 to date. The net income in 1928, including the company's equity in the subsidiary Eagle & Blue Bell Mining Co. at Eureka, was \$169,305, compared with \$309,459 in 1927. The production was 79,691 dry tons of ore with net smelter returns of \$809,921, compared with 100,052 dry tons and \$1,015,060 in net smelter returns for 1927. The metal content of ore shipped from the company's mines near Bingham is as follows:

¹¹ Bingham Mines Co. Twentieth Ann. Rept., for year ended Dec. 31, 1928.

Mine production of gold, silver, copper, lead, and zinc from mines of the Bingham Mines Co., Bingham, Utah, in 1928

Mine	Ore	Gold	Silver	Copper	Lead	Zinc	Smelter returns
	<i>Dry tons</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
Dalton & Lark-----	44, 879	1, 551	453, 051	1, 079, 502	10, 944, 134	190, 637	\$493, 128
Commercial-----	539	81	2, 432	47, 773	63, 471	9, 749	7, 042
Winamuck & Dixon-----	606	24	4, 675	4, 740	89, 157	-----	2, 891
	46, 024	1, 656	460, 158	1, 132, 015	11, 096, 762	200, 386	503, 061

The company received \$921,009 from ore shipments, royalties, etc., the net income was \$170,920, and the surplus at the end of 1928 was \$1,981,317.

The Winamuck & Dixon property, controlled by the Bingham Mines Co., was also operated by lessees. Shipments consisted of 583 tons of silver-lead ore and 23 tons of oxidized copper ore.

Leaching of ore in place continued during 1928 at the property of the Ohio Copper Co.,¹² at Lark. The output of copper in 1928 recovered from precipitates was 3,973,282 pounds, as compared with 4,825,587 pounds in 1927. The net profits, after deduction of fixed charges, taxes, adjustments, etc., but not depreciation and depletion, amounted to \$63,162, compared with \$46,454 in 1927. Development consisted of 2,537 feet of diamond drilling, 1,183 feet of drifting, 592 feet of raising, 7 feet of winzes, and 731 feet of inclined shaft. The company's report continues:

The high price prevailing for copper and the improvements made in milling practice in recent years are creating a substantial value to the company's mine and tailings dump, which have been dormant assets. The mine contains a large tonnage of developed low-grade copper ore which has not been mined for the past 10 years and as well an undeveloped portion known as the East ore body, which has been partially explored and should develop a further large tonnage of low-grade copper ore. * * *

A recent survey and sampling of the tailings dump estimated the contents at 4,995,459 tons, containing 0.475 per cent copper or 47,405,671 pounds. Preliminary experiments indicate that this material may be treated profitably. * * *

The exploration and development work in the lime beds has been diligently prosecuted. * * *

Development was directed first to opening up the limestone in the northern part of the property by sinking a 3-compartment inclined shaft from the Mascotte tunnel level, and second, to prospecting the smaller limestone areas on the Mascotte level in the southern part of the property. * * *

The shaft was completed to below the 700-foot level, measured on the incline, at the end of the year. It was all in the large porphyry mass that separates the northern from the southern limestone areas. Two diamond drill holes were run north from the shaft on the 400 and 600 levels to prospect the lower portion of the Commercial limestone. * * * Shortly after the beginning of 1929 a crosscut north of the 700-level cut the mineralized ground which had been found by drilling in 1927. It developed a strong fissure, with bands of rich lead-silver ore up to 2 feet wide in limestone.

The ore output of the Utah Metal & Tunnel Co. in 1928 was 29,843 dry tons, an increase of nearly 18,000 tons over 1927. The ore had a gross value of \$264,084 and a net smelter return of \$207,224. Most of the output was lead-zinc ore carried by an aerial tramway to International for milling. Development in 1928 consisted of 5,350

¹² Ohio Copper Co. of Utah Ann. Rept. for year ended Dec. 31, 1928.

feet of work, chiefly in drifts and crosscuts, as compared with 4,357 feet in 1927. The company received \$294,064 from the sale of ore and from other sources of income but paid no dividends in 1928. The operating expenses were \$230,910, and development costs were \$108,379. The net loss, including charges for depletion and depreciation, was \$81,696. The annual report of the company gives the following ore output for 1928: 29,843 tons of first-class smelting ore and milling ore containing 2,223.72 ounces of gold, 111,433 ounces of silver, 275,287 pounds of copper, 3,792,139 pounds of lead, and 1,403,700 pounds of zinc. The report says:

In the last three years thousands of feet of development work were completed with but little encouragement until the latter part of 1927 when the Washington limestone was penetrated on the 850 level and early in 1928 the still more important Levant limestone was discovered on the 1,800 level. * * * The area of the Highland Boy limestone on the 450 level has also shown considerable promise since development of the mine was undertaken. * * *

In January, 1929, a further examination of the territory west of the Occidental fault was made by the geologists of the International Smelting Co. and as a result of this examination and favorable report it was determined to develop the Highland Boy and Yampa lime beds west of the fault in two places. * * *

The development work since 1926 has been financed by and under the direction of the Utah-Delaware Mining Co.

The Montana-Bingham property, including the Tiewaukee mine, controlled by the Bingham Mines Co., produced 693 tons of ore, a mixture of first-class siliceous silver ore and sulphide lead ore. About 642 feet of work was done in 1928 in No. 3 tunnel. The company received \$3,157 from the sale of 693 dry tons of ore and 9 tons of copper precipitates. The ore contained 41 ounces of gold, 4,574 ounces of silver, 7,612 pounds of copper, and 74,811 pounds of lead.

The output of ore from the New England property, owned by the Bingham Metals Co., increased slightly. Most of the material was first-class sulphide iron ore containing gold, silver, and copper; the remainder was lead-zinc ore and silver-lead ore. The mine is opened by an inclined shaft and six levels; in 1928 nearly 2,600 feet of work was done in drifts and crosscuts, and the inclined shaft was sunk an additional 100 feet to the 900-foot level. The ore is hauled 3 miles to the siding of the Bingham & Garfield Railroad. The company's report to the industrial commission gave 3,800 tons of ore, including both milling ore and first-class smelting ore, which contained 3,407 ounces of gold, 30,373 ounces of silver, 87,797 pounds of copper, 412,512 pounds of lead, and 336,625 pounds of zinc.

The output of the Park-Bingham Mining Co., which controls the old Silver Shield and Bully Boy properties, consisted of about 9,000 tons of ore, most of which was lead-zinc-iron ore milled at Midvale. The output included several hundred tons of first-class lead ore shipped for smelting, but the chief product from the mill ore was silver-lead concentrate, as the mill heads contain considerably more lead than zinc; the output of recovered lead in 1928 was approximately three times that of the zinc. Development was continued through drifts from the Butterfield tunnel of the United States Smelting, Refining & Mining Co., and a body of high-grade silver ore was said to have been found on the 435-foot level of the Bonanza raise.

The Extra Session property near Lark, operated by the Bingham Prospect Mining Co., produced 4,000 tons of mixed ore, chiefly oxidized silver-lead ore. The product contained 177.27 ounces of gold, 119,685 ounces of silver, 23,957 pounds of copper, and 1,368,494 pounds of lead. The net smelter receipts from the sale of ore were \$75,785. Regular shipments began in June from Congor station on the Denver & Rio Grande Western Railroad. The property is opened by an inclined shaft, and 2,500 feet of development was done in 1928. The mine has developed into a large and regular producer, and shipments were increased early in 1929.

As in former years, lessees shipped several cars of ore from the Queen (Lavagnino) mine. One car of first-class lead ore was smelted, and several cars of lead-zinc ore were treated in the flotation plant at Midvale.

The Castro group, owned by the N. Floor Mining Co., was operated intermittently by lessees, who shipped a test lot of lead-zinc ore for milling. Several cars of first-class sulphide lead ore were smelted.

At Garfield the American Smelting & Refining Co. operated its copper smelter, consisting of reverberatories and converters, on custom material from Utah, California, Nevada, Idaho, and Colorado; the material was chiefly copper concentrate from the mills of the Utah Copper Co. Shipments of copper bullion in 1928 averaged more than 25,000,000 pounds a month.

Smelter district (Midvale and Murray).—The output of the Smelter district in 1928 consisted chiefly of old tailings containing lead and zinc from the old United States mill and material from the old Peck mill re-treated by flotation at Midvale. Some ore was also cleaned up from around the Utah Ore Sampler, and a little slag was shipped from a dump at Sandy.

At Midvale the lead smelter of the United States Smelting, Refining & Mining Co.¹³ treated custom ore and concentrates from Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, and Utah, producing about 39,500 tons of lead bullion, a decrease of more than 8,500 tons as compared with 1927. The smelter is equipped with seven blast furnaces, bag house, Cottrell plant, and Dwight-Lloyd sintering machines. The products, in addition to the usual shipments of lead bullion and lead-copper matte, are refined arsenic and cadmium. From 1919 to 1927, according to the company's annual reports, the works produced 354,248 tons of lead bullion, an average of 39,361 tons a year, but no exact figures were given for 1928 relative to the bullion output or its metal contents.

The new flotation plant at Midvale, a modern steel and concrete structure, treated on the average 722 tons of lead-zinc-iron ore a day; it was not worked at full capacity. From 1919 to 1928 this new flotation mill and the old wet concentration mill have treated about 1,745,600 tons of ore, chiefly from the company's mines at Bingham. The report says:

At the Midvale plant the lower lead prices caused a shortage of lead ore and reduced bullion production. The new flue system for the handling of

¹³ United States Smelting, Refining & Mining Co. Ann. Rept. for 1928.

waste gases was completed, and the anticipated improvement in the operating efficiency of the smelter was realized. The performance of the whole plant, including the flotation mill, was satisfactory and, despite the reduction in tonnage, production costs were on the whole lower than in the previous year.

Substantially all of the lead from the Bingham mines and Midvale plant was refined at the company's refinery at East Chicago, Ind., which has been operated with high efficiency and with improvement of costs over the preceding year.

At Murray the American Smelting & Refining Co. operated its lead plant, equipped with sampling mills, roasters, bag house, and blast furnaces; the bullion output in 1928 increased about 4,000 tons compared with 1927. This plant has been in operation more than 20 years, during which time interesting changes have been made, particularly in the roasting devices. Lead bullion is shipped East for refining, lead-copper matte is shipped to the copper plant at Garfield, owned by the same company, and arsenic dust to Colorado. Salt Lake City is the center for three large lead smelters and two copper plants, but no refining is done locally.

SAN JUAN COUNTY

Red Canyon district.—A little unusually fine placer gold was recovered from the banks of the east side of the Colorado River in Red Canyon, near Hanksville.

SANPETE COUNTY

The small output reported from Sanpete County consisted of a test lot of lead ore shipped from property near Manti and a small lot of ore containing silver and copper shipped from Chester near Moroni.

SUMMIT AND WASATCH COUNTIES

The Blue Ledge and Snake Creek districts in Wasatch County and the Uintah district in Summit County represent the producing area of the Park City region.

Mine production of gold, silver, copper, lead, and zinc in Park City mining region, Utah, 1927-28, and total, 1870-1928

Year	Mines producing	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc	Total value
		<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1927.....	12	1706,351	\$667,649	6,935,267	2,595,419	82,805,275	44,856,214	\$13,027,474
1928.....	14	2731,103	542,308	6,745,826	2,639,492	82,854,090	47,569,849	12,576,001
Total, 1870-1928.....	-----	(³)	7,260,538	189,031,674	49,859,410	1,811,681,621	237,291,406	267,254,116

¹ Includes 147,721 tons of old tailings.

² Includes 187,660 tons of old tailings.

³ Figures not available.

NOTE.—Total dividends, 1870-1928, \$59,988,899

Mine production of gold, silver, copper, lead, and zinc in Park City mining region, Utah, in 1928, by kinds of ore

Kind of ore	Mines producing	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc
		<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	5	11,326	589.13	192,419	41,427	179,750	-----
Lead.....	7	22,780	1,067.10	1,091,921	528,437	12,073,627	-----
Lead-zinc.....	9	696,997	24,577.93	5,461,486	2,069,328	70,600,713	47,569,849
	³ 14	731,103	26,234.16	6,745,826	2,639,492	82,854,090	47,569,849

¹ Includes 7,660 tons of old tailings sold to a smelter.

² Includes 180,000 tons of old tailings concentrated.

³ A mine producing more than one class of ore is counted but once in arriving at total for all classes.

The output of the Park City region came chiefly from the Park Utah mine, at Keetley (which is worked through the Ontario drain tunnel); the Silver King Coalition mine, in Woodside Gulch; the Daly West, Daly Judge, and New Quincy mines, in Empire Canyon; and the Ontario mine, in Ontario Canyon. The chief milling now done in the region is that of the Silver King Coalition mill, a new modern 800-ton flotation plant. The Judge mill treated ore from the Daly, Daly Judge, and Daly West mines; it is primarily a wet concentration plant and makes a lead concentrate, which is shipped for smelting, and a zinc-iron middling, which is re-treated at the International custom flotation plant.

The Silver King Coalition Mines Co.¹⁴ produced 16,681 tons of first-class ore (including 150 tons of lease ore), which was shipped for direct smelting, and 151,572 tons of second-class or mill ore, a total of 168,253 tons. There was a decrease in the output of first-class shipping ore but a large increase in the output of milling ore, resulting in a general increase in the recovered gold, silver, copper, lead, and zinc. After deducting smelter and freight charges, the company received \$3,398,011 from sales of ore; after adding other income (\$58,938), the total income for the year was \$3,456,949. Expenses for mining, milling, and other charges (including \$226,452 for taxes) amounted to \$1,892,725, leaving an operating profit of \$1,564,224. A deduction of \$74,517 was made to cover depreciation, which leaves a net profit for the year of \$1,489,707. The milling ore yielded 23,892 tons of lead concentrate and 9,707 tons of zinc concentrate. The accompanying table gives the average metal contents of all products from the property.

Gold, silver, copper, lead, and zinc contained in products of Silver King Coalition mine, Utah, in 1928

Kind of material	Gold		Silver		Copper		Lead		Zinc		Net smelter returns
	Total	Per ton	Total	Per ton	Total	Per centage	Total	Per centage	Total	Per centage	
First-class ore.....	Ounces 810.76	Ounce 0.0490	Ounces 928,457	Ounces 56.16	Pounds 573,009	1.73	Pounds 10,590,827	32.03	-----	-----	\$909,047
Lead concentrate.....	2,424.79	.1015	1,701,882	71.23	953,346	2.00	27,824,842	58.23	-----	-----	2,196,859
Zinc concentrate.....	186.45	.0192	123,339	12.71	108,425	.56	861,307	4.44	10,275,078	52.93	288,999
Lessee's ore.....	14.63	.0975	9,484	63.22	2,160	.72	129,473	43.16	-----	-----	3,105
	3,436.63	-----	2,763,162	-----	1,636,940	-----	39,406,449	-----	10,275,078	-----	3,398,010

¹⁴ Silver King Coalition Mines Co. Ann. Rept. for year ended Dec. 31, 1928.

During the year \$415,954 was spent in development (24,685 feet of drifting, raising, and sinking); dividends of \$1,342,382 were paid, making a total of \$22,561,021 to date. The amount paid in dividends in 1928 was the largest disbursement since the organization of the present company in 1907. A dividend of \$305,117 was also declared payable on January 2, 1929. An article¹⁵ on the Silver King Coalition mill, giving the equipment, reagents used, and the flow sheet, was published in November. The equipment, similar in general to the latest flotation plant for lead-zinc ore, consists chiefly of a gyratory crusher, a Symons cone crusher, 3 ball mills, 3 classifiers, 28 MacIntosh flotation machines, and 2 Oliver filters. The report says:

The most important development work during the year was the completion of the West End shaft and extending therefrom drifts on the 1,500 and 1,700 foot levels. New and undeveloped territory that heretofore had been practically inaccessible can now be economically explored. Recently, on the 1,700-foot level, extending from the West End shaft, ore has been intersected, conclusively demonstrating the value and continuity of the ore channel at a greater depth than has ever been explored in the property of the company.

It is the policy of the company to keep development and exploration work far in advance of ore extraction operations, thereby adding to and increasing ore reserves. At present the company is actively engaged in advancing exploration work into the undeveloped ground of the company.

Particular attention and study have been given to research and experimental work in the concentrating mill during the past year, resulting in increased efficiency of mill operations and the profitable treatment and separation of the lead and zinc content in the high-grade and complex ore. * * *

Recent mill tests indicate the possibility of further improved mill results and the installation of some additional equipment at an early date would seem advisable.

During the year there was expended for betterments and new equipment \$119,859. * * *

At present, the company owns 4,065 acres of patented ground in the Park City mining district, also 93.54 per cent of the capital stock of the Park City and Midnight Sun Mining Co., having an area of 164 acres.

The Park Utah Consolidated Mines Co. operated the Park City unit, consisting of the Daly West and Daly Judge properties, and the Park Utah unit, near Keetley, in the eastern part of the district in Wasatch County. The output of siliceous silver ore from the Park Utah mine has been steadily decreasing in recent years, and only about 800 tons of this material was shipped in 1928. The chief output of the mine is now lead-zinc ore, which is loaded on Union Pacific cars at Keetley and shipped to International and Midvale for milling. It is there separated into zinc concentrate, which is shipped to the electrolytic plants of the Anaconda Copper Mining Co. at Black Eagle and Anaconda, Mont., for leaching, and lead concentrate and iron concentrate, which are smelted at International. Besides gold and silver, the milling ore contains about 5 per cent of lead and 6 per cent of zinc. The Judge mill in Empire Canyon, which treats ore from the Daly, Daly West, and Daly Judge mines, is a wet concentration plant, including a few flotation cells used on jig tailings; the products are lead concentrate of smelting grade and zinc-iron middling, which is re-treated by flotation at International. An aerial tramway takes the first-class ore and the mill products to the loading station at Park City.

¹⁵ Keiser, H. D., Results of Remodeling a Flotation Mill at the Silver King Flotation Plant: Eng. and Min. Jour., vol. 126, Nov. 10, 1928, p. 748.

According to the annual report of the Park Utah Consolidated Mines Co. for 1928, the combined output of all mines, including the Ontario and Daly properties which comprise separate corporations, amounted to 335,028 tons of ore; ore and concentrates shipped contained 31,928 ounces of gold, 4,141,957 ounces of silver, 1,839,150 pounds of copper, 52,175,852 pounds of lead, and 48,821,553 pounds of zinc. There was a large decrease in the quantity of ore milled and in the content of gold, silver, copper, and lead. Much of the zinc contained in the lead ore and concentrate shipped to lead smelters and in ore shipped for milling was lost. The bulk of the ore was milled, and probably about 34,000,000 pounds of zinc was recovered from the zinc concentrate. The total metal contents of the ore and concentrates shipped are shown in the table that follows.

Gold, silver, copper, lead, and zinc contained in ore and concentrates shipped from the properties under control of Park Utah Consolidated Mines Co., Utah, in 1928

Mine	Ore and concentrates	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Park City unit.....	117, 221	3, 571	998, 682	551, 959	30, 313, 934	19, 852, 27
Park Utah unit.....	190, 406	27, 633	2, 313, 082	1, 104, 718	20, 558, 594	27, 293, 424
Ontario.....	27, 401	724	830, 193	182, 473	1, 303, 324	1, 675, 850
	335, 028	31, 928	4, 141, 957	1, 839, 150	52, 175, 852	48, 821, 553

The Park Utah Consolidated Mines Co., exclusive of the Ontario and Daly properties, was the largest producer of lead and zinc in Utah in 1928 and ranked second as a producer of gold and silver. Dividends paid to stockholders in 1928 amounted to \$1,674,800. The dividends paid to date, including those paid by the Judge Mining & Smelting Co., the Park City Mining & Smelting Co., and the Park Utah Consolidated Mines Co., total \$19,156,761. The Ontario Silver Mining Co. has paid \$14,157,500 and the Daly Mining Co. \$3,172,500, making \$36,486,761 paid by the companies now under the control of the Park Utah Consolidated Mines Co. Production was curtailed during the first half of the year as a result of the low metal prices, but development work was extensive. The following paragraphs are taken from the company's annual report:

The period of curtailment had the effect of reducing the 1928 tonnage approximately 15 per cent, as compared to that of 1927. Although the output of gold and silver was decreased in proportion to the decrease in tonnage, no loss was experienced in the output of combined lead and zinc, notwithstanding the drop in tons of ore mined. * * *

The development of the Western ore body of the Park Utah unit has been a source of much satisfaction to the management. This deposit has been exposed on the 1,800, the lowest level of the mine, for a continuous distance of 720 feet with an average width of 28 feet, a favorable comparison with its dimensions on the 1,500 or main drain tunnel level where it was first discovered. It is now estimated that this ore body contained approximately 595,000 tons between these levels, or at the rate of 2,000 tons for each foot of depth on the vein. Much of this tonnage remains to be mined. * * *

Preparations were made early in the past year to lower the water table of the mine to permit the mining of this deposit for an additional 150 feet on its downward extension below the 1,800 level. A pump shaft was first sunk to the 1,950 level and a connection, by raising, made with the main hoisting

shaft. Pumps capable of handling a continuous flow of 5,000 gallons per minute, with necessary spare units, were installed in the 1,800 level and connection made for the installation of pumps to lift this water from the 1,950 level. * * * The lowering of the water level to the 1,950 will also make it feasible to attack the ore left below the 1,800 level in the Eastern ore body. This Eastern deposit was the original producer of the mine and yielded a heavy tonnage of ores carrying high silver values. It is located about 1,500 feet east of the Western ore body, and the two apparently converge with depth.

An exploratory campaign is also under way in the Park Utah unit of the property to prospect virgin territory where favorable conditions exist for the discovery of additional detached deposits. One of these headings is to penetrate the beddings of the Park City limestones which have proved so productive in the Western sector of the Park City district. * * *

The Park City unit of the property has been a potent factor in operations of the company and has maintained its record as a heavy mineral producer, having produced in the past year over one-half of the entire output of lead and zinc of the combined properties. An energetic campaign to prospect certain portions of its great unexplored area has already brought favorable results in the discovery of new ore in both the Middle and Back veins.

The Ontario unit (98 per cent of whose stock is owned by the company) has responded well to development in the newer or Eastern portion of the property, and these operations have resulted in increased earnings for the year. No work was attempted in the older or Western portion of the mine or in ground below the drain tunnel level. Plans are now being formulated to unwater these lower workings during the coming summer for the purpose of mining the ore which is known to remain in them and to explore those areas below the tunnel which are still unprospected.

An article¹⁶ published in May describes the new ore-dumping equipment installed at the portal of the Ontario drain tunnel at Keetley. The company has also replaced its old haulage equipment with new 5-ton mine cars for the 10,000-foot haul from the No. 2 shaft to the portal at Keetley.

The Park Utah Consolidated Mines Co. received \$3,320,479 in 1928 from the sale of ore and from other income, paid out \$2,290,312 for various expenses (including taxes), and after deducting \$116,790 to cover depreciation had a net income for the year of \$913,377, compared with \$1,569,336 for 1927. Development cost \$296,488, and the operation of the mill cost \$108,791.

The Daly Mining Co., a separate incorporation controlled and operated by the Park Utah Consolidated Mines Co., produced about 2,000 tons of oxidized lead ore of smelting grade and mill ore treated at the Judge plant. The output was not given separately in the printed report.

The Ontario Silver Mining Co., also controlled and worked by the Park Utah Consolidated Mines Co., shipped 27,401 tons of mixed ore, which was chiefly lead-zinc ore milled in the flotation plant at International. The ore carries considerable silver and is highly siliceous but contains only small amounts of lead and zinc. Besides the lead-zinc ore, about 6,000 tons of old tailings was shipped for smelting. The mine was sixth in the production of silver in Utah in 1928 and tenth in the production of zinc. Operations were continuous, and about 4,800 feet of development was done.

The Glencoe mine, south of Keetley, was worked by the Park Galena Mining Co., which shipped a few hundred tons of sulphide lead ore for smelting and considerable lead-zinc ore for custom milling. The company also did 1,000 feet of drifting and sank its shaft

¹⁶ Keiser, H. D., New Tipple at the Park Utah Consolidated: Eng. and Min. Jour., vol. 125, May 19, 1929, p. 504.

an additional 80 feet. The property is opened by a vertical shaft 500 feet deep and by drifts and tunnels aggregating 4,200 feet. A new 100-ton flotation plant was built early in 1928 but was run only intermittently, chiefly for testing purposes. According to the statement to the industrial commission, the product shipped contained 144 ounces of gold, 25,593 ounces of silver, 17,726 pounds of copper, 539,514 pounds of lead, and 239,806 pounds of zinc. The net proceeds were \$29,167.

The New Quincy Mining Co., owning claims in the center of the original Park City region south of the Daly mine, suddenly developed into an important shipper of silver-lead-zinc ore in March and during the year shipped 12,649 tons of lead-zinc ore to the custom flotation plant at International. The ore was said to average \$23.74 in metals a ton. The company received \$300,262 from the sale of ore and the total expenses were \$144,473, leaving a net profit of \$155,789. A large amount of development was done during the year, and the company was preparing to drive a raise from the 1,300-foot level in order to facilitate the shipment of additional ore. At present the ore is delivered to the loading station at Park City through one of the Ontario tunnels. The report to the industrial commission gave the contents of the ore shipped as follows: 396 ounces of gold, 362,393 ounces of silver, 346,594 pounds of copper, 3,094,053 pounds of lead, and 4,442,484 pounds of zinc. The company's statement for 1928 contains the following paragraphs:

During the last six months of the year 1928 development work on the property proved most satisfactory. From the time ore was discovered early in 1928 each month shows a decided improvement. * * *

A large part of the present production is coming from a new fissure which promises to keep up a steady production. * * * In our 1,236 stope, where measurements have been taken along the fissure, our past 60 days' experience indicates that this fissure will produce more than 250 tons of ore per lineal foot of an average value of from \$20 to \$25 per ton. * * *

In addition to this fissure we are developing three others which are contributing regularly to our output. * * *

On the No. 3 fissure there are from 6 inches to 2 feet of exceptionally rich ore. * * * At present ore is being mined at the rate of 100 to 120 tons per day. We are now preparing to put up another raise from our 1,300 level, and when this is completed we expect to double our present production. * * *

Concentrates from creek tailings obtained in Woodside Gulch below the Silver King Coalition mine and also in Empire Canyon below the Daly Judge mill were shipped from the two flotation plants operated by Charles Moore. Siliceous tailings containing chiefly silver were also shipped to Garfield for smelting.

The Clarissa and Bone groups, owned by the Star of Utah Mining Co., produced several cars of mixed lead-zinc ore, which was tested by flotation at Midvale. Development consisted of 70 feet of sinking and about 2,000 feet of drifting in the main tunnel.

Development continued at the Three Kings property, and one lot of silver-lead ore was shipped to Midvale for smelting. Properties near Keetley which were undergoing development were the Park Standard, Sphinx, and Konold prospects.

The Park Premier Mining Co. has about 3,000 acres in the Elkhorn district, which will be prospected by churn drilling. This property is controlled and the geologic work directed by the International Smelting Co.

Development, both drifting and shaft sinking, was done at the property of the Park City Consolidated Mining Co. in Frog Valley, east of Park City, near the old Judge electrolytic zinc plant. A compressor and other mining equipment were installed early in 1928.

TOOELE COUNTY

In Tooele County 25 mines produced 48,716 tons of ore and old tailings, a decrease of 20,074 tons from that reported from 23 mines in 1927. The recovered gold decreased from \$80,764 to \$77,886, the silver from 287,613 to 273,768 fine ounces, the copper from 229,816 to 167,143 pounds, the lead from 15,207,230 to 14,773,417 pounds, and the zinc from 4,045,448 to 1,494,868 pounds. The total value of these metals decreased from \$1,490,912 to \$1,210,154. The decrease in total value was due to the decrease in shipments of lead ore and lead-zinc ore from the Bullion Coalition (Honerine) property near Stockton, operated by the Combined Metals Reduction Co.

At International, west of Bingham, the International Smelting Co., a subsidiary of the Anaconda Copper Mining Co., continued to operate its 1,200-ton flotation plant and its copper and lead smelting plants on custom ore. The copper plant is equipped with roasters, a Cottrell plant, 5 reverberatory furnaces, and 5 converters. The lead plant has 10 Dwight-Lloyd sintering machines and 5 blast furnaces. On an average, 2 reverberatories and 4 blast furnaces were active in 1928.

The custom flotation plant at International treated about 428,000 tons of ore from Utah, Colorado, and Arizona, making lead concentrate and iron concentrate for treatment locally and zinc concentrate for shipment to Anaconda and Great Falls, Mont.

The copper plant treated 117,029 tons of copper material and the lead plant 294,526 tons of ore and concentrates, from which 145,613,624 pounds of lead, 20,654,286 pounds of copper, 8,439,372 ounces of silver, and 65,117.08 ounces of gold were produced.

From 1917 to 1928 the smelting plants treated 1,458,146 tons of copper material and 2,672,680 tons of lead material, from which 385,026 ounces of gold, 69,858,333 ounces of silver, 215,049,282 pounds of copper, and 963,531,515 pounds of lead were recovered, largely from Utah ores. No marked changes were made in the flotation plant at International, which was reviewed in 1927 by McKenna.¹⁷ Flotation experiments were conducted on oxidized ores, chiefly from the Tintic district, and plans were drawn for a new plant to be constructed in 1929 for the treatment of a large quantity of ore of that type. It will be located near the custom flotation plant (formerly Utah Consolidated mill) at International.

Blue Bell district.—One small lot of oxidized silver-lead ore was shipped from the R. E. P. claim, 10 miles southwest of Lofgreen.

Clifton district (Gold Hill).—Seven lode mines in the Clifton district produced 195 tons of ore, yielding \$67 in gold, 1,578 ounces of silver, 2,995 pounds of copper, and 50,223 pounds of lead, valued in all at \$4,335, or \$22.23 in metals a ton. The entire output was a first-class smelting product, consisting chiefly of oxidized lead ore

¹⁷ McKenna, W. J., Flotation of Custom Lead-Zinc-Iron Ores as Practiced by the International Smelting Co.'s Tooele Plant: Trans. Am. Inst. Min. and Met. Eng., August, 1927.

shipped by a lessee from the property of the Western Utah Copper Co. The remainder of the output consisted of small test lots of ore from the Christmas, Gold Hill Standard, Wilson, Undine, Mineral Hill, and Utah-Nevada properties. No ore was shipped from the Rube mine; in 1927 the property produced 155 tons of rich gold ore.

Columbia district.—Three lode mines in the Columbia district produced 256 tons of ore, yielding \$16 in gold, 664 ounces of silver, 363 pounds of copper, and 43,837 pounds of lead, valued in all at \$2,999, or \$11.71 in metals a ton. About 1,000 feet of development was done at the Hill Top property, and a few cars of oxidized lead ore and concentrate were shipped from Dunbar on the Los Angeles & Salt Lake Railroad. The property is equipped with a 20-ton concentration plant using jigs and tables. Lessees shipped several cars of oxidized lead ore from the Sharp and Sunday mines.

Erickson district.—One small car of oxidized lead ore was shipped from the Imperial Lead property, which produced about 500 tons of ore a year from 1924 to 1926. Tunnel work at the Utah Majestic property was said to have opened much new ore.

Lakeside district.—The Monarch property, under development, produced several cars of sulphide lead ore, which was shipped from Delle on the Western Pacific Railroad. The property is opened by a 100-foot shaft and nearly 2,000 feet of drifts and tunnels; the American Smelting & Refining Co. is developing the property.

Ophir district.—Six lode mines in the Ophir district produced 2,122 tons of ore, which yielded \$1,172 in gold, 30,986 ounces of silver, 23,078 pounds of copper, 202,328 pounds of lead, and 104,062 pounds of zinc, valued in all at \$40,705, or \$19.18 in metals a ton; of this output, 1,828 tons was first-class smelting ore and 294 tons was milling ore reduced to 244 tons of concentrates. Shipments from the Ophir Hill Consolidated property, a large producer since 1890, ceased in 1925, and the output of the Ophir district has been relatively small since that time. In 1928, however, a few hundred tons of ore containing chiefly silver was shipped from the dump of the Ophir Hill Consolidated property.

The company's development campaign to open the southern extension of the Ophir Hill ore body was unsuccessful and work ceased on August 16, 1928. More than \$200,000 was reported spent in this project, the only reward being a large flow of water. There is, however, an unusually large quantity of old tailings containing chiefly silver, lead, copper, and zinc below the old mill site at Ophir, the result of concentration since 1901. Lessees shipped nearly 1,000 tons of dump ore containing chiefly silver from the Chloride Point property. Several years ago the Lion Hill Consolidated Mining & Milling Co. treated a large quantity of ore from this property in a cyanidation plant. The Kearsarge Standard and Ophir Bullion groups were consolidated by the Kearsarge Standard Mining Co., and eight cars of mixed siliceous silver ore and oxidized lead ore were shipped to the International smelter. The company controls what is known as Shoo Fly Hill and a large tract of land which it is planning to develop near the Hidden Treasure mine. The Mono mine lies to the west, the Hidden Treasure to the south, and the Ophir Queen to the east of the Kearsarge Standard group. The Hidden Treasure mine, north of Ophir and beyond the Ophir Hill Consoli-

dated ground, was operated by a lessee until May, and several cars of lead-zinc ore were shipped to International for custom milling; one car of oxidized lead ore was shipped directly to the lead smelter. Two cars of siliceous silver ore were shipped from the Buffalo property of the Tintic Ophir Mining Co., and two cars of oxidized lead ore containing silver were shipped from the property of the Ophir-Mono Mines (Inc.), where much development was done. More than 1,400 feet of tunnel work was done at the Lakes of Killarney property, and development was started at the Jim Fisk property by the Fisk Ophir Mining Co. and the necessary mining equipment installed.

Rush Valley district (Stockton).—Four lode mines in the Rush-Valley district produced 45,970 tons of ore and old tailings, which yielded \$76,615 in gold, 239,651 ounces of silver, 139,971 pounds of copper, 14,443,351 pounds of lead, and 1,390,806 pounds of zinc, valued in all at \$1,159,520, or \$25.22 in metals a ton. The output consisted of 36,470 tons of first-class silver-lead ore and of 4,552 tons of milling ore which with 4,948 tons of old tailings was reduced to 2,597 tons of concentrates. The Honerine and Galena King mines at Bauer were operated by the Combined Metals Reduction Co.; more than 19,000 tons of first-class silver-lead ore were shipped to International and Murray for smelting; and about 10,000 tons of milling ore and old tailings were treated locally at the Bauer flotation plant. The statement to the industrial commission gave 21,296 tons of ore and concentrate containing 725 ounces of gold, 123,794 ounces of silver, 8,201,504 pounds of lead, and 1,915,300 pounds of zinc.

The output of lead-zinc ore from the Honerine mine near Stockton was decidedly less than in 1927. These mines, which are old producers, are extensively developed; considerable work was done in drifts, raises, and winzes in 1928. The capacity of the flotation plant of the Combined Metals Reduction Co., at Bauer, was increased to 200 tons of ore a day and was operated the entire year on ore from Utah, Nevada, Idaho, and Colorado. Lead concentrate and lead-iron concentrate from the flotation plant were shipped to International and Murray, and the zinc product was shipped to Anaconda and Great Falls, Mont. The operation of this flotation plant has been distinctly successful and the plant is becoming increasingly important in custom work. An article¹⁸ published in 1928 describes the flotation practice at this plant and gives the flow sheet. The equipment consists chiefly of a coarse crusher, a Hardinge ball mill, an Akins classifier, 8 Fagergren flotation machines, Dorr thickeners, and an American filter. The plant was built to treat complex ore from Pioche, Nev., but the company is now securing and treating much custom ore. Early in 1929 work was started to double the capacity of the mill.

A marked increase was made in the production of metals from the Tip Top and Cyclone claims, about 2 miles from Stockton. These claims were worked by the Bluestone Lime & Quartzite Co., and more than 15,000 tons of ore containing gold, silver, lead, and a little copper was shipped to the lead plant at International. The company re-

¹⁸ Keiser, H. D., Flotation Equipment of the Combined Metals Reduction Co.: Eng. and Min. Jour., vol. 126, Aug. 18, 1928, p. 253.

ported to the industrial commission the shipment of 19,064 tons of first-class ore containing 2,840 ounces of gold, 101,200 ounces of silver, and 6,046,564 pounds of lead; the net proceeds were given as \$79,668. The property has an 800-foot vertical shaft, but ore is now delivered through the Honerine tunnel. The mine was a relatively large producer of both gold and lead.

Two cars of oxidized lead ore were shipped from shallow workings in the Lookout property, $2\frac{1}{2}$ miles east of Stockton, and a small car of silver-lead ore was shipped from the Salvation Hercules property. Tunnel work was continued at the Jumbo property of the Stockton Standard Mining Co. and by the Gibson-Muirbrook Mines (Inc.).

Silver Islet district.—A sample lot of rich silver ore was shipped from the Silver Glance property by way of Wendover on the Western Pacific Railroad.

Wild Cat Range district.—One car of silver ore containing a small quantity of copper was shipped from the Silver Queen mine, owned by the Utah Silver Queen Mining Co. Fluorite of good grade also occurs in this district.

UTAH COUNTY

American Fork district.—The output of the American Fork district increased considerably in 1928 and was chiefly that of the Live Yankee mine, operated by the Yankee Mines Co. The ore consists mainly of pyrite, chalcopryrite, and chalcocite and is valuable chiefly for its gold, which averages about 1 ounce to the ton in the first-class ore. The ore is hauled 19 miles by teams to the railroad at American Fork. The 50-ton concentration plant equipped with jigs and tables was rebuilt in 1928, and about 3,000 tons of copper ore was concentrated. More than 1,500 tons of first-class copper ore was also shipped for smelting. The mine was one of the largest producers of gold in Utah in 1928; nearly 300 feet of development was done in tunneling, raising, and stoping. The statement to the industrial commission gave 2,454 tons of shipping ore and concentrate containing 3,067 ounces of gold, 16,393 ounces of silver, 145,196 pounds of copper, and 11,289 pounds of lead; the net proceeds were \$21,759. A few cars of sulphide lead ore were shipped from the Blue Rock mine; the mine is owned by the Pacific Gold Mining & Milling Co. and is in American Fork Canyon near the divide between American Fork Canyon and Little Cottonwood Canyon. The output was comparatively small, but early in 1929 the company was equipping the property with a small flotation plant.

Mine production of gold, silver, copper, lead, and zinc in American Fork district, Utah, 1927-28, and total, 1870-1928

Year	Mines producing	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
		<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1927-----	5	1,190	\$32,209	9,207	87,369	20,706	-----	\$50,179
1928-----	3	4,676	62,176	19,381	116,089	139,016	-----	98,294
Total, 1870-1928-----	-----	93,578	515,357	2,030,178	950,734	31,509,744	313,926	4,593,841

North Tintic district.—More than 900 feet of drifting and sinking was done at the Lehi Tintic property.

Tintic district.—The following mines, which are in Utah County, in the eastern part of the Tintic district, are mentioned in the general review under Juab County: Tintic Standard, North Lily, Eureka Standard, Eureka Lilly, Mountain View, Iron King, Colorado Consolidated, Yankee, and Utah Consolidated.

WASHINGTON COUNTY

A small production of gold came from the Bull Valley district, but mines in the Tutsagubet district were idle. Active development was started by the American Smelting & Refining Co. at the old Silver Reef property near Leeds, Harrisburg district. This mine was a large producer of silver from 1875 to 1909, chiefly from 1875 to 1890.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO^{1 2}

(MINE REPORT)

By CHAS. W. HENDERSON

SUMMARY

The total calculated gross value of the recoverable gold, silver, copper, lead, and zinc from ore and gravel produced in New Mexico in 1928 amounted to \$18,815,863, compared with \$15,662,076 in 1927—an increase of 20 per cent. There were 99 producing mines in 1928, of which 93 were lode and 6 were placers, a decrease of 9 lode mines and 4 placer mines from 1927.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver prices for 1904 to 1915 are from the report of the Director of the Mint and represent the equivalent value per fine ounce based on average price and average rate of exchange; for 1916 and 1917, dealers' buying price, New York; for 1918, early estimated average price furnished by the Bureau of the Mint; for 1919, dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper prices for 1904 to 1915 are those at New York; for 1916 and later years, weighted average price, for each year, of all grades of primary metal sold by producers. The lead prices for 1904 to 1915 are those at New York; for 1916, outside spot quotations, New York; for 1917 and later years, weighted average price, for each year, of all grades of primary metal sold by producers. The zinc prices for 1904 to 1914 are those at St. Louis; for 1915 and later years, weighted average price, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1904-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1904.....	\$0. 58	\$0. 128	\$0. 043	\$0. 051	1917.....	\$0. 824	\$0. 273	\$0. 086	\$0. 102
1905.....	. 61	. 156	. 047	. 059	1918.....	1. 00	. 247	. 071	. 091
1906.....	. 68	. 193	. 057	. 061	1919.....	1. 12	. 186	. 053	. 073
1907.....	. 66	. 20	. 053	. 059	1920.....	1. 09	. 184	. 08	. 081
1908.....	. 53	. 132	. 042	. 047	1921.....	1. 00	. 129	. 045	. 05
1909.....	. 52	. 13	. 043	. 054	1922.....	1. 00	. 135	. 055	. 057
1910.....	. 54	. 127	. 044	. 054	1923.....	. 82	. 147	. 07	. 068
1911.....	. 53	. 125	. 045	. 057	1924.....	. 67	. 131	. 08	. 065
1912.....	. 615	. 165	. 045	. 069	1925.....	. 694	. 142	. 087	. 076
1913.....	. 604	. 155	. 044	. 056	1926.....	. 624	. 14	. 08	. 075
1914.....	. 553	. 133	. 039	. 051	1927.....	. 567	. 131	. 063	. 064
1915.....	. 507	. 175	. 047	. 124	1928.....	. 585	. 144	. 058	. 061
1916.....	. 658	. 246	. 069	. 134					

¹ Work on manuscript completed January, 1930.

² Published data on the metal resources of New Mexico are scanty. The mine report series of Mineral Resources, of which this chapter forms a part, have been published annually since 1904. Annual reports of the Director of the Mint begin with the year 1880. Professional Paper No. 68 of the U. S. Geological Survey, published in 1910, is a most valuable reference book covering the whole State. The Report of the Appraisal of Mining Properties of New Mexico, by J. R. Finlay, for the State Tax Commission, Santa Fe, 1921-22, contains valuable notes. Additional references are given in the section of this chapter, "Review by counties and districts," pp. 538 to 557.

Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1904-1928, in terms of recovered metals

Year	Mines producing			Ore (short tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total		Fine ounces	Value	Fine ounces	Value
1904	80	24	104	102,339	18,476.00	\$381,930	214,553	\$124,441
1905	52	21	73	145,629	15,359.56	317,510	369,192	225,207
1906	52	19	71	207,691	14,174.80	293,019	491,127	333,966
1907	104	23	127	219,992	15,962.88	329,982	705,544	465,659
1908	108	26	134	135,434	14,452.37	298,757	405,044	214,673
1909	111	17	128	164,156	11,585.38	239,491	397,783	206,847
1910	85	23	108	191,865	23,337.26	482,424	843,987	455,753
1911	85	20	105	232,699	36,900.84	762,808	1,354,540	717,906
1912	119	26	145	1,352,286	37,947.57	784,446	1,536,701	945,071
1913	108	20	128	2,217,660	42,663.17	881,926	1,631,273	985,289
1914	115	24	139	2,232,853	56,680.79	1,171,696	1,777,445	982,927
1915	148	26	174	2,797,072	70,680.96	1,461,105	2,005,531	1,016,804
1916	191	19	210	3,870,950	66,877.47	1,382,480	1,766,274	1,162,208
1917	177	15	192	4,576,827	51,478.64	1,064,158	1,394,365	1,148,957
1918	119	9	128	4,749,784	33,080.02	682,791	782,421	782,421
1919	86	6	92	2,155,998	31,717.36	655,656	837,418	937,908
1920	93	6	99	2,250,718	23,234.61	480,302	768,042	837,166
1921	40	9	49	611,576	9,521.26	196,822	571,899	571,899
1922	74	17	91	1,576,920	19,964.02	412,693	752,240	752,240
1923	104	16	120	3,111,050	26,689.12	551,713	747,127	612,644
1924	86	10	96	3,040,652	24,803.56	512,735	795,070	532,697
1925	92	12	104	3,358,566	26,561.40	549,073	735,124	510,176
1926	116	12	128	3,825,894	19,630.72	405,803	450,934	281,383
1927	102	10	112	3,442,184	29,241.87	604,483	890,083	504,677
1928	93	6	99	4,073,974	32,912.41	680,360	827,793	484,259
Total, 1904-1928				50,644,769	753,884.04	15,584,163	23,051,510	15,793,178

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1904	4,972,170	\$636,438	3,122,872	\$134,283	13,493,835	\$688,186	\$1,965,278
1905	6,126,025	955,660	1,510,209	70,980	15,142,254	893,393	2,462,750
1906	7,028,670	1,356,533	2,987,369	170,280	17,292,655	1,054,852	3,208,650
1907	10,990,015	2,198,003	3,809,881	201,924	750,085	44,255	3,239,823
1908	6,112,630	806,867	873,763	36,698	3,576,516	168,096	1,525,091
1909	5,393,146	701,109	5,029,767	216,280	13,085,945	706,641	2,070,368
1910	4,614,386	586,027	4,320,841	190,117	18,088,129	976,759	2,691,080
1911	4,057,040	507,130	2,966,222	133,480	10,237,176	583,519	2,704,843
1912	34,030,964	5,615,109	5,494,018	247,231	13,566,637	936,098	8,527,955
1913	56,308,706	8,727,850	3,946,364	173,640	16,523,161	925,297	11,694,002
1914	59,307,925	7,887,954	1,763,641	68,782	18,403,392	938,573	11,049,932
1915	76,788,366	13,437,964	4,542,361	213,491	25,404,064	3,150,104	19,279,468
1916	92,747,289	22,815,833	8,214,189	566,779	36,570,649	4,900,467	30,827,767
1917	105,568,000	28,820,064	9,108,804	783,357	30,200,000	3,080,400	34,896,936
1918	98,264,563	24,271,347	8,398,239	596,275	24,050,324	2,188,579	28,521,413
1919	51,150,541	9,514,000	2,886,513	152,985	7,594,644	554,409	11,814,958
1920	54,400,691	10,009,727	2,869,522	229,562	10,013,580	811,100	12,867,857
1921	14,267,338	1,840,487	678,601	30,537	228,000	11,400	2,651,145
1922	31,937,207	4,311,523	3,012,223	165,672	4,496,806	256,318	5,898,446
1923	61,356,802	9,019,450	3,832,427	268,270	16,496,000	1,121,728	11,573,805
1924	74,691,436	9,784,578	3,634,511	290,761	20,759,200	1,349,348	12,470,119
1925	76,427,825	10,852,751	6,420,060	558,545	18,492,300	1,405,415	13,875,960
1926	81,642,379	11,429,933	6,960,366	556,829	24,104,800	1,807,860	14,481,808
1927	74,251,863	9,726,994	16,052,855	1,011,330	59,603,000	3,814,592	15,662,076
1928	89,854,646	12,939,069	15,610,501	905,409	62,406,000	3,806,766	18,815,863
Total, 1904-1928	1,182,200,623	208,752,400	128,046,122	7,973,497	480,579,152	36,174,155	284,277,393

Gold and silver produced at placer mines in New Mexico, 1904-1928

Year	Gold		Silver		Total value
	Fine ounces	Value	Fine ounces	Value	
1904	7,228.39	\$149,424			\$149,424
1905	4,805.34	99,335	662	\$404	99,739
1906	1,296.81	26,807	195	133	26,940
1907	935.56	19,340	173	114	19,454
1908	1,122.20	23,198	153	81	23,279
1909	1,064.73	22,010	162	84	22,094
1910	1,262.30	26,094	374	202	26,296
1911	905.29	18,714	162	86	18,800
1912	818.79	16,926	140	86	17,012
1913	380.27	7,861	90	54	7,915
1914	1,410.22	29,152	330	182	29,334
1915	447.09	9,242	55	28	9,270
1916	537.74	11,116	72	47	11,163
1917	589.16	12,179	92	76	12,255
1918	150.83	3,118	21	21	3,139
1919	239.89	4,959	33	37	4,996
1920	105.84	2,188	20	22	2,210
1921	400.59	8,281	61	61	8,342
1922	190.21	3,932	39	39	3,971
1923	204.05	4,218	30	24	4,242
1924	176.04	3,639	27	18	3,657
1925	97.62	2,018	13	9	2,027
1926	129.98	2,687	45	28	2,715
1927	280.97	5,808	32	18	5,826
1928	65.16	1,347	17	10	1,357
Total, 1904-1928	24,845.07	513,593	2,998	1,864	515,457

GOLD

The mine production of recoverable gold in New Mexico in 1928 amounted to 32,912.41 fine ounces, valued at \$680,360, compared with 29,241.87 fine ounces, valued at \$604,483, in 1927. San Miguel County produced 45.52 per cent of the total in 1928, Hidalgo 32 per cent, Grant 17.1 per cent, and Colfax 2.7 per cent. Copper ore yielded 50.1 per cent of the total, lead-zinc ore 45.7 per cent, and dry and siliceous ore 3.3 per cent. Placer mines yielded less than 1 per cent.

SILVER

The mine production of recoverable silver in New Mexico in 1928 amounted to 827,793 fine ounces, valued at \$484,259, compared with 890,083 fine ounces, valued at \$504,677, in 1927. San Miguel County produced 59.9 per cent of the total, all from the lead-zinc ore from the Pecos mine, in the Willow Creek district; Grant County 18.5 per cent, chiefly from the Central district; Hidalgo County 14.8 per cent, chiefly from the copper ore of the Lordsburg district; Catron County 2 per cent, from the Mogollon district; and Socorro County 1.9 per cent, all from the Magdalena district. Placer mines yielded 17 ounces of silver.

Lead-zinc ore yielded 66.8 per cent of the total; copper ore 23.8 per cent, chiefly from Hidalgo and Grant Counties; dry and siliceous ore 3.2 per cent, chiefly from Catron and Hidalgo Counties; and lead ore 6.2 per cent, chiefly from the Central district, Grant County.

COPPER

The mine production of recoverable copper in New Mexico in 1928 amounted to 89,854,646 pounds, valued at \$12,939,069, compared with 74,251,863 pounds, valued at \$9,726,994, in 1927. Of the total

in 1928, 95.5 per cent was produced in Grant and Hidalgo Counties, chiefly from the operations of the Santa Rita mines, in the Central district, Grant County, and from the Eighty-Five mine, in the Lordsburg district, Hidalgo County. San Miguel County, third in order of output, yielded 2.4 per cent from the lead-zinc ore of the Pecos mine. Copper ore yielded 97.1 per cent of the total and lead-zinc ore 2.6 per cent.

LEAD

The mine production of recoverable lead in New Mexico in 1928 amounted to 15,610,501 pounds, valued at \$905,409, compared with 16,052,855 pounds, valued at \$1,011,330, in 1927. The chief lead-producing districts were the Willow Creek district, San Miguel County; the Central district, Grant County; and the Magdalena district, Socorro County. Lead-zinc ore yielded 78.7 per cent of the total and lead ore 20.5 per cent.

ZINC

The mine production of recoverable zinc in New Mexico in 1928 amounted to 62,406,000 pounds, valued at \$3,806,766, compared with 59,603,000 pounds, valued at \$3,814,592, in 1927. The chief zinc-producing districts in 1928 were the Willow Creek, in San Miguel County, and the Central (Hanover) in Grant County. The only output of zinc from Magdalena, Socorro County, was from lead-zinc ore shipped for making pigments.

Zinc concentrates produced in 1928 amounted to 73,981 tons, containing as shipped 3,673.08 ounces of gold, 199,967 ounces of silver, 1,612,546 pounds of copper, 1,903,018 pounds of lead, and 75,236,682 pounds of zinc. The average content in zinc was therefore 50.8 per cent.

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1928, by counties, in terms of recovered metals

County	Mines producing			Ore (short tons)	Gold (lode and placer)	Silver (lode and placer)	
	Lode	Placer	Total			Fine ounces	Value
Catron.....	2		2	81	\$4, 189	16, 800	\$9, 828
Colfax.....	1	2	3	3, 000	18, 476	145	85
Dona Ana.....	4		4	872	14	3, 959	2, 316
Grant.....	30	4	34	3, 740, 623	116, 281	153, 453	89, 770
Guadalupe.....	1		1	13, 700		2, 359	1, 380
Hidalgo.....	13		13	97, 884	217, 687	122, 171	71, 470
Lincoln.....	4		4	44		253	148
Luna.....	1		1	40	85	188	110
Otero.....	3		3	3, 850	4, 104	858	502
Sandoval.....	1		1	66		29	17
San Miguel.....	1		1	201, 013	309, 697	495, 930	290, 119
Santa Fe.....	6		6	3, 560	4, 192	6, 759	3, 954
Sierra.....	11		11	500	3, 485	6, 754	3, 951
Socorro.....	8		8	6, 798	1, 980	16, 183	9, 467
Torrance.....	7		7	1, 943	170	1, 952	1, 142
Total, 1927.....	93	6	99	4, 073, 974	680, 360	827, 793	484, 259
	102	10	112	3, 442, 184	604, 483	890, 083	504, 677

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1928, by counties, in terms of recovered metals—Continued

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Catron.....	17,000	\$2,448					\$16,465
Colfax.....							18,561
Dona Ana.....	39,000	5,616	105,897	\$6,142			14,088
Grant.....	81,131,090	11,682,877	2,822,328	163,695	15,512,000	\$946,232	12,998,855
Guadalupe.....	1,200,000	172,800					174,180
Hidalgo.....	4,681,243	674,099	754,551	43,764			1,007,020
Lincoln.....	1,118	161	10,535	611			920
Luna.....			9,000	522			717
Otero.....	80,243	11,555	287,000	16,646			32,807
Sandoval.....	6,500	936					953
San Miguel.....	2,120,000	305,280	10,385,000	602,330	46,410,000	2,831,010	4,338,438
Santa Fe.....	257,639	37,100	98,535	5,715	145,000	8,845	59,806
Sierra.....	5,403	778	146,448	8,494			16,708
Socorro.....	128,327	18,479	991,207	57,490	339,000	20,679	108,095
Torrance.....	187,083	26,940					28,252
Total, 1927.....	89,854,646	12,939,069	15,610,501	905,409	62,406,000	3,806,766	18,815,863
	74,261,863	9,726,994	16,052,855	1,011,330	59,603,000	3,814,592	15,662,076

MINING INDUSTRY

The output of ore from metal mines in New Mexico in 1928 was 4,073,974 tons, the largest quantity mined and milled in any year since the record outputs of 4,576,827 tons in 1917 and 4,749,784 tons in 1918. The value of the recovered gold (\$680,360) was the largest since 1918 but was still below the records made each year from 1911 to 1917, when the Mogollon gold and silver mines, at Mogollon, and the Aztec gold mine, at Baldy, were active producers. The quantity of silver recovered (827,793 ounces) was slightly below the production of 1927 and very much below the yearly outputs from 1911 to 1917. The quantity of copper recovered was the highest recorded for the State except for 1916, 1917, and 1918, lead the highest recorded for the State except for 1927, and zinc the highest in the history of mining in the State.

The American Metal Co.'s Pecos mine at the junction of Willow Creek and Pecos River, San Miguel County, which entered the producing list in 1927 as the largest single producer of gold, silver, lead, and zinc in the State, continued to hold that rank in 1928. The production of this mine and other zinc-producing mines in New Mexico gave the State a recoverable zinc production in 1928 of 62,406,000 pounds, as compared with 165,660,189 pounds in Montana, 93,857,352 pounds in Utah, 71,462,000 pounds in Colorado, and 62,526,648 pounds in Idaho.

Since 1912 the largest mine in New Mexico in point of tonnage and recoverable gross value has been the Chino Mines at Santa Rita, one of the large porphyry low-grade copper mines in the United States. In 1928 this mine increased its daily milling tonnage to 9,852 dry tons, from 8,170 tons in 1927. Improvements at the mill promise a daily capacity of 15,000 tons, and the open pits, mined by power shovels, are prepared to supply the ore. In the meantime the opening of the Estrella ore body for underground mining is being continued.

The third largest producing mine in New Mexico in 1928 was the Eighty-Five branch of the Calumet & Arizona Copper Co., at Lordsburg, Hidalgo County. Development work was continued at this

mine, and production of highly siliceous copper-gold-silver ore for use at the Calumet & Arizona copper smelter at Douglas, Ariz., was continued at the usual yearly rate of about 90,000 dry tons.

At Mogollon development work was carried on and there was some production. From 1890 to 1926 this district was a very important contributor to the silver and gold production of the State. In the Magdalena district, once an important zinc and lead producer, the Ozark flotation mill was idle, and work in the district was mostly confined to that done by lessees. The limited operations at the copper properties of the Burro Mountain branch of the Phelps Dodge Corporation were completely closed late in 1928, and the plant and town were placed in charge of watchmen.

The Central mining district, Grant County, including Hanover, Fierro, Santa Rita, Vanadium, Bayard, and Georgetown, continued to be the principal mining district in point of value of metals produced and in variety of metals. In addition to the Chino Mines, other properties in the Central district were the Empire Zinc Co.'s zinc mine at Hanover, with its 100-ton flotation mill; the Black Hawk Consolidated Mines Co.'s 100-ton flotation mill at its zinc-lead mine at Hanover; the Peru zinc-lead mine at Hanover, with its 200-ton flotation mill at Wempe; the Ground Hog mine at Vanadium; and the iron and copper mines of the Hanover Bessemer Iron & Copper Co., at Fierro. East of Santa Rita, in the Swartz district, the remodeled Royal John mill was operated for a time. North of the Central district, in the Pinos Altos district, small placer-mining operations were carried on and intermittent lode mining was done. West of the Central district, at Silver City, iron-manganese ore was mined from Boston Hill and Chloride Flat.

In Colfax County the Aztec gold mine, on Mount Baldy, was again in operation. In Dona Ana County small mining operations were continued in the Organ district, and grinding of fluorspar ores was done at Mesilla Park. In Otero County, there was small production in the Orogrande, High Rolls, and Sacramento Mountains districts. In Lincoln County, there was small production in the Nogal and Red Cloud districts. The Luna County mining districts—Cooks Peak, Florida Mountains, Fremont, Tres Hermanas, and Victorio—were all practically idle. The Sierra County mines were nearly all idle.

The greatly increased production of copper ore from the "Red Beds" near Pastura, Guadalupe County, and the reopening of similar beds and the shipping of ore from near Scholle, Torrance County, were of interest.

Placer mining in New Mexico has dwindled almost to insignificance. Two sluicing operations in Colfax County yielded 20.51 fine ounces of gold and 5 ounces of silver; four sluicing operations in Grant County yielded 44.65 ounces of gold and 12 ounces of silver.

ORE CLASSIFICATION

Ore sold or treated in New Mexico in 1928, with content in terms of recovered metals

Source	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry gold ore.....	3,029	895.47	197	632	-----	-----
Dry gold and silver ore.....	59	198.15	9,341	234	-----	-----
Dry silver ore.....	3,928	71.82	16,566	93,302	51,599.	-----
	7,016	1,165.44	26,104	94,168	51,599	-----
Copper ore.....	3,733,442	16,481.69	197,389	87,257,916	35,800	-----
Lead ore.....	13,211	155.13	51,584	136,997	3,196,233	-----
Lead-zinc ore.....	249,233	15,044.99	552,699	2,365,565	12,291,869	53,055,000
Zinc ore.....	71,072	-----	-----	-----	35,000	9,351,000
	4,066,958	31,681.81	801,672	89,760,478	15,558,902	62,406,000
Total, lode mines.....	4,073,974	32,847.25	827,776	89,854,646	15,610,501	62,406,000
Total, placers.....	-----	65.16	17	-----	-----	-----
	4,073,974	32,912.41	827,793	89,854,646	15,610,501	62,406,000

Ore sold or treated in New Mexico in 1928, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Colfax.....	3,000	873.27	140	-----	-----	-----
Grant.....	8	11.51	5	-----	-----	-----
Sierra.....	21	10.69	52	632	-----	-----
	3,029	895.47	197	632	-----	-----
Total, 1927.....	8,984	2,232.41	2,370	89,359	1,859	-----

DRY GOLD AND SILVER ORE

	Ore	Gold	Silver	Copper	Lead	Zinc
Catron.....	20	177.64	7,759	-----	-----	-----
Sierra.....	39	20.51	1,582	234	-----	-----
	59	198.15	9,341	234	-----	-----
Total, 1927.....	176	234.69	3,865	2,792	427	-----

DRY SILVER ORE

	Ore	Gold	Silver	Copper	Lead	Zinc
Hidalgo.....	2,869	71.00	13,553	89,600	12,965	-----
Lincoln.....	5	-----	37	-----	-----	-----
Sierra.....	26	.82	147	49	-----	-----
Socorro.....	1,028	-----	2,829	3,653	38,634	-----
	3,928	71.82	16,566	93,302	51,599	-----
Total, 1927.....	22,532	49.11	55,575	205,717	680,158	-----

COPPER ORE

	Ore	Gold	Silver	Copper	Lead	Zinc
Catron.....	61	25.00	9,041	17,000	-----	-----
Dona Ana.....	299	.30	150	35,000	150	-----
Grant.....	3,619,796	5,489.08	76,142	80,769,273	33,001	-----
Guadalupe.....	13,700	-----	2,359	1,200,000	-----	-----
Hidalgo.....	90,073	10,445.39	98,180	4,588,713	2,649	-----
Lincoln.....	8	-----	51	451	-----	-----
Otero.....	2,889	198.53	620	80,243	-----	-----
Sandoval.....	66	-----	29	6,500	-----	-----
Santa Fe.....	2,576	189.89	4,039	257,639	-----	-----
Sierra.....	41	122.68	470	2,632	-----	-----
Socorro.....	1,990	2.60	4,353	113,382	-----	-----
Torrance.....	1,943	8.22	1,952	187,083	-----	-----
	3,733,442	16,481.69	197,389	87,257,916	35,800	-----
Total, 1927.....	3,124,447	14,442.62	122,093	71,491,246	127,503	-----

Ore sold or treated in New Mexico in 1928, by counties, with content in terms of recovered metals—Continued

LEAD ORE

County	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dona Ana.....	573	0.38	3,809	4,000	105,747	-----
Grant.....	3,369	29.05	23,195	116,252	1,072,527	-----
Hidalgo.....	4,942	14.22	10,438	2,930	738,937	-----
Lincoln.....	31	-----	162	667	10,535	-----
Luna.....	40	4.11	188	-----	9,000	-----
Otero.....	961	-----	238	-----	287,000	-----
Santa Fe.....	15	.30	50	-----	2,466	-----
Sierra.....	373	13.89	4,503	1,856	146,448	-----
Socorro.....	2,907	93.18	9,001	11,292	823,573	-----
Total, 1927.....	13,211	155.13	51,584	136,997	3,196,233	-----
	10,678	127.07	54,104	206,714	2,724,711	-----

LEAD-ZINC ORE

Grant.....	46,403	50.80	54,099	245,565	1,681,800	6,173,000
San Miguel.....	201,013	14,981.59	495,930	2,120,000	10,385,000	46,410,000
Santa Fe.....	969	12.60	2,670	-----	96,069	145,000
Socorro.....	848	-----	-----	-----	129,000	327,000
Total, 1927.....	249,233	15,044.99	552,699	2,365,565	12,291,869	53,055,000
	215,138	11,872.60	637,510	2,098,412	11,980,646	49,293,000

ZINC ORE

Grant.....	71,047	-----	-----	-----	35,000	9,339,000
Socorro.....	25	-----	-----	-----	-----	12,000
Total, 1927.....	71,072	-----	-----	-----	35,000	9,351,000
	57,336	2.40	934	6,915	28,113	10,310,000

METALLURGIC INDUSTRY

The markets for New Mexico ore and concentrates are all outside the borders of the State. Lead ores and concentrates are sold to the American Smelting & Refining Co.'s lead plant,³ at El Paso, Tex., and to the Copper Queen lead plant at Douglas, Ariz. Copper ore and concentrates are sold to the American Smelting & Refining Co.'s copper plant at El Paso, to the Copper Queen copper smelter at Douglas, and to the Calumet & Arizona copper plant at Douglas. In the past some copper ore has gone to the American Smelting & Refining Co.'s copper plant at Hayden, Ariz. Zinc ore and concentrates are shipped to the United States Zinc Co.'s natural-gas retort plants at Amarillo, Tex., and Henryetta, Okla.; to the Mineral Point Zinc Co.'s producer-gas retort plant at Depue, Ill.; to the Ozark Smelting & Mining Co.'s zinc pigment plant at Coffeyville, Kans.; to the American Metal Co.'s natural-gas retort plant at Blackwell, Okla., and producer-gas retort plant at Langeloth, Pa.; and to the Empire Zinc Co.'s zinc-oxide plant, at Canon City, Colo. Iron ore and iron-manganese ore go to Pueblo, Colo., and manganese ore goes to Birmingham, Ala.

The Grubnau Chemical Co.'s Wetherill grate zinc oxide plant at Waldo, N. Mex., remained idle.

Active metallurgical plants in New Mexico in 1928 were the copper flotation concentrator of the Chino Mines, at Hurley, with a capacity

³ For latest published description see Young, George J., *The El Paso Smelter: Eng. and Min. Jour.*, Press, vol. 119, 1925, pp. 1041-1047.

of 12,000 tons in 24 hours, operated at 9,852 tons daily average; the Pecos lead-zinc-copper-silver-gold-iron selective flotation mill, near Glorieta, with a capacity of 600 tons, operated at 558 tons daily average; the Peru lead-zinc-copper-silver-gold-iron selective flotation mill, at Wemple, with a capacity of 200 tons, operated at 180 tons daily during the time of operation; the Empire Zinc Co.'s zinc-iron selective flotation mill, at Hanover, with a capacity of 200 tons, operated at capacity; the Black Hawk zinc-lead-copper-silver-gold-iron selective flotation mill, near Hanover, with a capacity of 145 tons, operated at capacity during the period of operation; the Aztec amalgamation-concentration gold mill, at Baldy, with a capacity of 50 tons, operated at 25 tons during the period of operation; the Black Cloud selective flotation-concentration mill, at Kelly, with a capacity of about 30 tons, operated for a few weeks; the Carbon Hill flotation mill, near Steins, with a capacity of 50 tons, operated for a short time; the Carnahan lead-zinc-silver selective flotation mill, with a capacity of 50 tons, operated for a short time only; the Royal John lead-zinc-copper-silver selective flotation mill, 28 miles east of Santa Rita, with a capacity of 85 tons, operated at 60 tons daily during the period of operation; and the Hanover Bessemer Iron & Copper Co.'s magnetic separation (magnetite from gangue) plant, at Fierro, with a capacity of 1,200 tons, operated at 600 tons daily during December.

Inactive plants in 1928 were the Ozark zinc-lead-copper-silver-gold-iron selective flotation plant, at Kelly, with a capacity of 200 tons; the Empire Zinc Co.'s zinc-lead-iron magnetic separation plant, at Hanover, with a capacity of 250 tons; the American zinc-lead-silver-gold-iron selective flotation mill, at Hachita, with a capacity of 100 tons; and the Burro Mountain branch (Phelps Dodge) copper concentrator, with a capacity of 2,000 tons.

Mine production of metals in New Mexico in 1928, by methods of recovery

Method of recovery	Material treated	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Ore amalgamated ¹	3,000	873.27	140			
Concentrates smelted.....	² 225,096	20,519.08	625,670	81,575,407	13,360,679	62,067,000
Ore smelted.....	148,783	11,454.90	201,966	8,279,239	2,249,822	339,000
Placer.....		65.16	17			
		32,912.41	827,793	89,854,646	15,610,501	62,406,000

¹ 20 pounds of quicksilver was used. No ore was cyanided.

² From 3,922,191 tons of ore concentrated.

Gross metal content of New Mexico concentrates produced in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Copper.....	130,740	5,387.10	60,784	82,489,054		
Copper-lead.....	16,448	12,418.27	355,930	1,523,000	11,428,070	4,112,000
Lead.....	3,927	139.19	67,618	362,702	3,231,821	34,746
Zinc.....	73,981	3,673.08	199,967	1,612,546	1,903,018	75,236,682
	225,096	21,617.64	684,299	85,987,302	16,562,909	79,383,428

Mine production of metals from concentrating mills in New Mexico in 1928, by counties

County	Ore treated	Concentrates and recovered metal					
		Concen- trates pro- duced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Grant.....	3, 713, 594	151, 328	5, 437. 90	114, 883	79, 450, 607	1, 716, 800	15, 512, 000
Hidalgo.....	4, 615	923	5. 01	7, 682	646, 804	646, 804	-----
San Miguel.....	201, 013	71, 931	14, 981. 59	495, 930	2, 120, 000	10, 385, 000	46, 410, 000
Santa Fe.....	969	323	12. 60	2, 670	-----	96, 069	145, 000
Socorro.....	2, 000	591	81. 98	4, 505	4, 800	516, 006	-----
Total, 1927.....	3, 922, 191 3, 255, 612	225, 096 248, 457	20, 519. 08 16, 457. 24	625, 670 656, 601	81, 575, 407 66, 787, 241	13, 360, 679 12, 269, 541	62, 067, 000 59, 279, 000

Gross metal content of New Mexico crude ore shipped to smelters in 1928

Class of ore	Ore	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry gold ore.....	29	22. 20	57	680	-----	-----
Dry gold and silver ore.....	59	198. 15	9, 341	282	-----	-----
Dry silver ore.....	3, 923	71. 82	16, 566	93, 670	68, 838	-----
Copper ore.....	137, 298	11, 094. 59	136, 605	8, 905, 736	72, 455	-----
Lead ore.....	6, 596	68. 14	39, 397	193, 467	2, 262, 501	40, 343
Lead-zinc ore.....	848	-----	-----	-----	184, 822	408, 642
Zinc ore.....	25	-----	-----	-----	-----	15, 000
Total, 1927.....	148, 783 180, 164	11, 454. 90 10, 863. 04	201, 966 232, 816	9, 198, 835 8, 490, 490	2, 588, 616 4, 330, 045	463, 990 408, 607

Mine production of metals from New Mexico crude ore shipped to smelters in 1928, by counties, in terms of recovered metals

County	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Catron.....	81	202. 64	16, 800	17, 000	-----	-----
Dona Ana.....	872	. 68	3, 959	39, 000	105, 897	-----
Grant.....	27, 029	142. 54	38, 558	1, 680, 483	1, 105, 528	-----
Guadalupe.....	13, 700	-----	2, 359	1, 200, 000	-----	-----
Hidalgo.....	93, 269	10, 525. 60	114, 489	4, 681, 243	107, 747	-----
Lincoln.....	44	-----	253	1, 118	10, 535	-----
Luna.....	40	4. 11	188	-----	9, 000	-----
Otero.....	3, 850	198. 53	858	80, 243	287, 000	-----
Sandoval.....	66	-----	29	6, 500	-----	-----
Santa Fe.....	2, 591	190. 19	4, 089	257, 639	2, 466	-----
Sierra.....	500	168. 59	6, 754	5, 403	146, 448	-----
Socorro.....	4, 798	13. 80	11, 678	123, 527	475, 201	339, 000
Torrance.....	1, 943	8. 22	1, 952	187, 083	-----	-----
Total, 1927.....	148, 783 180, 164	11, 454. 90 10, 863. 04	201, 966 232, 816	8, 279, 239 7, 462, 935	2, 249, 822 3, 783, 314	339, 000 324, 000

REVIEW BY COUNTIES AND DISTRICTS

CATRON COUNTY

*Mogollon district.*⁴—In March, 1928, William J. Weatherby, trustee, bought at receiver's sale the property of the American Silver Corporation, locally known as the Little Fanney and the Johnson groups.

⁴ Scott, David B., Ore Deposits of the Mogollon District: Trans. Am. Inst. Min. and Met. Eng., vol. 53, 1920, pp. 289-310; Kidder, S. J., Mining Methods in Mogollon District, N. Mex.: Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 529-549; Ferguson, H. G., Geology and Ore Deposits of the Mogollon Mining District, N. Mex.: U. S. Geol. Survey Bull. 787, 1927, 100 pp.

Later he started development work on the property, and in the latter part of the year miners under his supervision and lessees mined and shipped to the Selby Calif.) and El Paso (Tex.) smelters one small lot of exceedingly high-grade dry gold and silver ore, one car of high-grade dry gold and silver ore, and several cars of copper-silver-gold ore. The Fanny 200-ton cyanidation mill, closed in January, 1926, remained idle. The Deadwood Mining Co. continued development work at its property but extracted no ore. William J. Weatherby did assessment work at the Oaks group.

The Mogollon mining district seems to have had its first real start about 1885 with the discovery of the Last Chance, Top, and Confidence claims. Because of its isolated location production was small until about 1903, when cyanidation of the silver ores began. The second Dorr classifier was sold in 1904 to the Ernestine Mining Co., then operating the Last Chance mill. One of the most vital factors in the cost of mining and milling in this district has always been the remote location and the consequent high cost of transportation of supplies into the camp. The town is only 37½ miles in an air line from Clifton, Ariz., but there is no highway between the two towns. Supplies were first brought by wagons and later by trucks from Silver City, 75 miles by highway, 52½ miles in an air line.

Mine production of gold, silver, copper, and lead in Mogollon or Cooney district, Catron County, N. Mex., 1904-1928, in terms of recovered metals ¹

Year	Ore	Gold	Silver	Copper	Lead	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	
1904	11, 276	\$61, 880	79, 014	422, 308		\$161, 763
1905	15, 534	97, 158	240, 943	295, 175		290, 180
1906	16, 076	127, 907	268, 567			310, 533
1907	20, 698	105, 413	418, 338	150, 000		411, 516
1908	19, 546	116, 418	278, 939			264, 256
1909	23, 945	111, 464	249, 413	46	49	241, 167
1910	50, 514	304, 210	595, 669			625, 871
1911	102, 219	531, 358	1, 067, 038	1, 873	1, 862	1, 097, 206
1912	101, 361	524, 858	1, 093, 158	184	386	1, 197, 197
1913	115, 739	619, 886	1, 306, 766	4, 418	1, 217	1, 409, 912
1914	136, 124	629, 102	1, 410, 327		590	1, 409, 035
1915	119, 710	509, 165	1, 301, 059		2, 426	1, 168, 916
1916	118, 257	373, 068	1, 008, 483	858	3, 232	1, 037, 084
1917	111, 934	258, 620	722, 642	414	1, 593	854, 327
1918	56, 452	119, 710	302, 902	235	282	422, 690
1919	56, 531	148, 136	382, 800	9, 521		578, 643
1920	41, 895	125, 631	329, 489	582	2, 050	485, 045
1921	48, 870	126, 791	310, 774			437, 565
1922	48, 106	142, 133	322, 460			464, 593
1923	47, 644	179, 351	398, 714			506, 296
1924	72, 736	230, 960	618, 094			645, 083
1925	52, 118	163, 322	449, 699			475, 413
1926	976	12, 444	28, 404	24, 400		33, 584
1927	89	4, 678	3, 591			6, 714
1928	81	4, 189	16, 800	17, 000		16, 465
Total, 1904-1928	1, 388, 431	5, 627, 852	13, 204, 083	927, 014	13, 687	14, 551, 054

¹ In reports prior to 1921 the production for the Mogollon district will be found under Socorro County.

COLFAX COUNTY

*Mount Baldy district (Baldy, Elizabethtown, Therma).—*The Maxwell Land Grant Co. resumed operation of its mill (capacity, 50 tons in 24 hours) at the Aztec mine in February, 1928, and continued the operation at the rate of about 25 tons a day until November 1, when mining of ore was stopped. After that time, development work only was continued. Approximately 1,200 feet of drifts and raises were

driven in 1928. The length of adits, drifts, and crosscuts on this property totals about 2 miles, but much of the underground openings was reported on February 25, 1929, as in disuse and abandoned for the time being. The mill is equipped with 1 Universal crusher, two 10-foot Lane Chile-type mills, 2 sets of silver-plated amalgamating plates, 1 cone classifier, 2 Wilfley tables, 1 Dorr thickening tank, and 2 J. I. B. flotation machines (not used in 1928). The Aztec mine was discovered in 1868 and in a few years made an estimated output of \$1,250,000 to \$1,500,000. It was then abandoned until 1912. Between 1912 and 1920 it produced \$1,680,718 in bullion (ranging in fineness from 0.856 to 0.889 in gold and 0.142 to 0.105 in silver) and \$243,079 (mostly gold) in concentrates. Shortly after the discovery of "bonanza" ore in 1914 the cost of producing gold was as low as \$2 an ounce, but in 1919 it rose to \$13.50 owing to the large amount of timbering required and to other operating difficulties.⁵ From 1920 to 1925, inclusive, the mine was operated by lessees in a desultory manner with occasional production, and in 1926-27 the company repaired the workings and reopened old stopes, the ore from which was sufficient to operate the mill for nine months in 1927.

Placer deposits in the creeks radiating from Mount Baldy, also discovered about 1868, have had an estimated production to 1928 of \$3,000,000 or more, the heaviest production being, of course, in the first 10 years following discovery. Placer production in 1928 was small; it came from two placers—the Kaiser placer on Willow Creek and the Maxwell Land Grant placer on South Ponil Creek.

Mine production of gold, silver, copper, and lead in Mount Baldy district, Colfax County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold		Silver (lode and placer)	Copper	Lead	Total value
		Lode	Placer				
	<i>Short tons</i>			<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	
1904	380	\$3,638	\$90,639	67	-----	-----	\$94,316
1905	13	445	31,994	181	-----	-----	32,549
1906	-----	-----	14,492	93	-----	-----	14,555
1907	-----	-----	11,914	83	-----	-----	11,969
1908	-----	-----	11,274	66	-----	-----	11,309
1909	83	1,705	16,037	127	-----	-----	17,808
1910	93	3,433	9,588	261	-----	2,182	13,258
1911	2,306	31,547	9,860	1,254	5,587	-----	42,770
1912	3,025	27,316	8,385	634	6,243	-----	37,121
1913	3,222	15,588	4,550	254	1,147	134	20,475
1914	2,860	63,129	4,930	577	11,083	154	69,658
1915	2,673	350,745	2,631	2,483	14,092	787	357,138
1916	6,064	417,258	5,039	2,803	447	-----	424,251
1917	10,180	342,994	5,739	2,381	4,784	930	352,081
1918	10,031	258,034	2,133	1,880	4,619	-----	263,188
1919	10,557	238,656	3,885	1,634	-----	-----	244,371
1920	5,637	81,722	1,634	607	-----	-----	84,018
1921	-----	5,361	3,447	52	-----	-----	8,860
1922	3,730	76,341	1,472	570	-----	-----	78,383
1923	2,315	48,725	1,811	430	592	-----	50,975
1924	-----	242	2,303	15	-----	-----	2,555
1925	2,000	51,688	970	432	-----	-----	52,958
1926	1,572	18,748	1,851	175	250	-----	20,743
1927	6,328	32,962	2,155	353	1,687	-----	35,538
1928	3,000	18,052	424	145	-----	-----	18,561
Total, 1904-1928	76,069	2,088,329	249,157	17,557	50,531	4,187	2,359,608

⁵ Chase, C. A., and Muir, Douglas, *The Aztec Mine, Baldy, N. Mex.*: Trans. Am. Inst. Min. and Met. Eng., vol. 68, 1923, pp. 270-281. See also Finlay, J. R., *Report of Appraisal of Mining Properties of New Mexico*, Santa Fe, State Tax Commission, 1921-22; Lee, W. T., *The Aztec Gold Mine, Baldy, N. Mex.*; Contributions to Economic Geology, 1915, Part I: U. S. Geol. Survey Bull. 620, 1916, pp. 325-330.

DONA ANA COUNTY

Organ district.—During November and December, 1928, a lessee on the Bennett-Stephenson group shipped 17 cars of lead-silver ore to the lead plant of the El Paso smelter. A lessee on the Torpedo group shipped 5 cars of copper-silver ore (mined in 1920) to the copper plant of the El Paso smelter. Development work at the Homestake mine resulted in the shipment to the El Paso smelter of 1 car of lead-silver ore. A 2-ton lot of silver-lead ore was shipped to the El Paso smelter from the Chappel prospect.

Mine production of gold, silver, copper, lead, and zinc in Dona Ana County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1904	5, 580		24, 101	40, 000	1, 581, 488		¹ \$87, 103
1905	6, 566	\$6, 710	21, 776	96, 058	327, 707	30, 000	¹ 52, 150
1906	16, 220		34, 051	434, 000	1, 207, 193		¹ 175, 727
1907	6, 084	6	25, 612	776, 125	675, 189		207, 920
1908	3, 090		9, 283	21, 150	379, 697		23, 660
1909	2, 816	248	16, 975	10, 600	772, 023		43, 650
1910	2		15		705		39
1911	5		111	353	1, 561		173
1912	78	17	1, 790	6, 685	26, 129		3, 397
1913	155	30	1, 232	10, 189	9, 557		2, 774
1914	451	927	3, 564	78, 180	29, 897		14, 462
1915	1, 599	2, 426	8, 335	241, 749	19, 170		49, 859
1916	2, 615	503	7, 948	206, 187	34, 696	106, 679	73, 144
1917	417	98	4, 705	16, 121	162, 965		22, 391
1918	6, 076	109	45, 661	110, 676	1, 616, 479	114, 000	198, 251
1919	1, 856		4, 726	319, 323	29, 981		66, 276
1920	1, 407	44	4, 779	168, 853	120, 100	12, 852	46, 971
1921	47		676		20, 000		1, 576
1922	43		413		12, 576		1, 104
1923	25					14, 000	952
1924	55		300	8, 893	2, 064		1, 531
1925	221		2, 684	1, 313	55, 400		6, 868
1926	2, 462	104	5, 131	12, 377	235, 200		23, 855
1927	218	77	1, 862	1, 923	71, 651		5, 899
1928	872	14	3, 959	39, 000	105, 897		14, 088
Total, 1904-1928	58, 960	11, 313	229, 689	2, 599, 755	7, 497, 325	277, 531	1, 123, 820

¹ Revised figures.

EDDY COUNTY

Assessment work only was done in 1928 at the Lucky Strike group of claims, west of Carlsbad; in 1927 a car of copper ore was shipped from this group.

GRANT COUNTY ⁶

*Burro Mountain district (Tyrona).*⁷—The Azure Leasing Co. in 1928 reopened the Emerald mine and shipped 4,000 tons of 3 per cent copper ore to the Douglas (Ariz.) and El Paso (Tex.) copper smelters. No underground development work was done in 1928 at the Burro Mountain properties of the Phelps Dodge Corporation, at Tyrona, but lessees extracted and shipped to Douglas, Ariz., and to El Paso, Tex., over 2,000 tons of copper ore, carrying slightly over 5 per cent copper, 59.2 per cent silica, 4.7 per cent iron, 4.3 per cent sulphur, and little more than a trace of silver. The company continued through the

⁶ For a description of the geology of Bear Mountain, Burro Mountain, Chloride Flat, Fierro, Fleming, Georgetown, Hanover, Lone Mountain, Pinos Altos, and Santa Rita see Paige, Sidney, U. S. Geol. Survey Geol. Atlas U. S., Silver City folio (No. 199), 1916.

⁷ Paige, Sidney, Copper Deposits of the Tyrona district, N. Mex.; U. S. Geol. Survey Prof. Paper 122, 1922.

greater part of 1928 the leaching of the 700,000 to 1,000,000 ton waste dump from operations in former years, and then abandoned the leaching of this dump. This test leaching has been under way since April, 1921. The results of the tests in 1928 were so satisfactory that the equipment of the test plant was removed to the smelter at Douglas, Ariz., where during 1929 similar work on a more elaborate scale will be carried out on Morenci branch low-grade ores.

The mining property of the Burro Mountain branch is opened by two shafts 600 and 800 feet deep and a haulage adit 5,000 feet long. The report of the Phelps Dodge Corporation for the calendar year 1928 (dated New York, March 22, 1929) says of the Burro Mountain branch that "underground pumping at Tyrone has been discontinued and the property will be allowed to remain idle until such time as a permanent demand for increased copper production justifies its reopening." The report also makes pertinent note of the beginning of construction at El Paso, Tex., of an electrolytic refinery, with capacity to treat 100,000 tons a year, under agreement between the Phelps Dodge Corporation, the Calumet & Arizona Mining Co., and the Nichols Copper Co. In the latter part of 1928 the Phelps Dodge Sales Co. was organized and incorporated as a joint enterprise to sell the product of Phelps Dodge Corporation, Calumet & Arizona Mining Co., Nichols Copper Co., and the Old Dominion Copper Co.

Mine production of gold, silver, copper, and lead in Burro Mountain district, Grant County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold	Silver	Copper	Lead	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	
1904.....	18,421			973,231		\$124,574
1905.....	45,110			1,804,416		281,489
1906.....	66,285			2,608,005		503,345
1907.....	59,069			2,163,810		432,762
1908.....	20,097	\$271	387	801,841		106,319
1909.....	36,037	284	2,160	1,160,838		152,316
1910.....	2,632	421	1,769	80,205		11,562
1911.....	681	558	3,623	28,089		5,989
1912.....	286		63	51,583		8,550
1913.....	100	2	19	15,155		2,362
1914.....	9,804		739	285,014		38,316
1915.....	18,505		3,558	1,406,286		247,904
1916.....	270,325	1,426	23,491	8,392,329		2,081,396
1917.....	490,679	5,354	41,523	14,574,355		4,018,368
1918.....	607,899	5,960	50,323	17,100,044		4,279,994
1919.....	188,670	2,129	16,275	6,101,102		1,155,162
1920.....	231,559	2,160	27,656	6,605,669		1,247,748
1921.....	171,505	2,357	18,184	4,496,124		600,541
1922.....						
1923.....	50,563	21	724	2,374,163		349,617
1924.....	3,846			2,665,093		349,127
1925.....	7,542		664	1,890,662		268,935
1926.....	1,403	445	2,476	678,250	20,000	98,545
1927.....	851	873	4,993	250,687		36,544
1928.....	6,640	523	1,805	889,347		129,645
Total, 1904-1928.....	2,308,509	22,784	200,432	77,396,298	20,000	16,531,110

*Central district (Bayard, Fierro, Georgetown, Hanover, Santa Rita).—*The Chino Mines at Santa Rita were operated continuously in 1928, yielding 3,596,144 tons of copper milling ore, all mined by steam and electric shovels. Since May, 1926, this property has been known as the New Mexico division of the Nevada Consolidated Copper Co. and from early in 1924 to 1926 was part of the Ray Consolidated Copper Co.; it is best known under the name of its former owner, the

Chino Copper Co., which acquired the property in 1909 and after much expenditure started open-pit mining with steam shovels and large-scale milling operations. The ore of the Chino Mines is low grade (between 1 and 2 per cent copper) and is mainly sulphide, but much of it is partly oxidized. The principal ore minerals are chalcocite, native copper, and cuprite. The ore is transported from the mine by broad-gage railroad to Hurley, where is located the flotation concentration plant, in which an average of 9,852 tons daily was milled in 1928. Improvements at the Hurley concentrator in 1928 and early 1929 will give a capacity of 15,000 tons a day. The concentrate produced is smelted to blister copper at the El Paso Smelting Works. Occasionally crude ore of higher grade than the milling ore is shipped direct from the mines to the El Paso smelter. The ore shaft that serves the mining operations for the ore bodies to be mined by underground methods was sunk to a total depth of 661 feet to the main haulage way, and connection was made from the bottom of this shaft with the man and material shaft, which was completed in 1927. No actual production of ore from underground sources will be required for the next two years, as the shovel pit is in condition to provide the full-capacity requirements of the concentrator.

In the milling of the ore some crushing is done at the mine. The equipment of the mill at Hurley, as of February, 1929, was as follows: Two No. 8 McCauley gyratory crushers, one 7-foot Symons cone crusher, five 4 by 5 foot Hummer screens, five 4¼ by 6 foot Chino impact screens, three 72-inch Garfield rolls, six 7 by 10 foot rod mills, one 8 by 12 foot rod mill, fourteen 7 by 10 foot ball mills, seventeen 8-foot Dorr classifiers, seven 15-foot Dorr bowl classifiers, eighteen 6½ by 27 foot Southwestern flotation cells, two 6½ by 18 foot Southwestern flotation cells, two 6½ by 9 foot Southwestern flotation cells, four 14 by 14 foot Oliver filters, one 13¼ by 12¼ foot interior vacuum filter, and one 75 by 20 foot and one 48 by 20 foot Dorr thickening tank.

The Twenty-Second Annual Report of the Nevada Consolidated Copper Co., for the year ended December 31, 1928, contains the following with respect to the operations of the Chino Mines division and to the revenue and costs of the combined Nevada, Ray, and Chino divisions:

Exploration and ore reserves.—At Chino Mines approximately 25 per cent of the ore mined during the year from the shovel pit came from areas lying outside the previously known and measurable ore body, and undoubtedly additional tonnages of the same nature will be encountered in future years as the pit area is extended.

Development at the mines.—At Chino Mines the ore shaft to serve the mining operations for the ore bodies to be mined by underground methods was sunk to a total depth of 661 feet to the main haulage level, and connection made from the bottom of this shaft with the man and material shaft which was completed in the previous year. The concreting of the ore shaft is now in progress. Underground development work was continued from the man shaft throughout the year and 3,984 feet driven. The ground explored to date is of favorable character and very suitable for mining by the improved methods which are being developed at Ray Mines and which it is planned to use for the extraction of underground Chino ores. Development drifts have not as yet been sufficiently advanced to penetrate these ore bodies for any great distance or to reach their expected limits, but the amount of ore already disclosed and its value are fully in accord with what was indicated by previous churn drilling. During the coming year the man and material shaft will be provided with its permanent equipment, the installation of which will permit underground development to progress more rapidly than is possible

with the temporary hoisting equipment now available. No actual production of ore from underground sources will be required for the next two years, as the shovel pit is in condition to provide the full capacity requirements of the concentrator.

Mining operations.—At Chino Mines, where all ores were mined by power shovels, the mining cost for the year, exclusive of depreciation and taxes but including all other expenses of every nature, was 32.22 cents per ton. The cost of stripping at the Chino Mines for the year was 51.98 cents per cubic yard.

The mining costs stated above do not include the usual charges made at all mines against each ton of ore produced to cover prepaid development or stripping expense or both. This charge for the year was at Chino Mines 45 cents per ton.

Construction and improvements at the mill.—At Chino Mines the Hurley concentrator is being greatly improved, and its capacity when these betterments are completed will be about 15,000 tons a day. Additional classifiers have already been installed and the flotation equipment almost entirely remodeled. Other changes now in process include the substitution of cone crushers for the gyratories still remaining in the coarse crushing plant and the erection of additional screening towers, and the installation of additional grinding mills and classifiers in the fine grinding department. It will be the end of the second quarter of 1929 before all of the new equipment is placed in commission and its full benefit secured, but the improvements effected to date have already resulted in a very marked reduction in the cost of milling.

Milling operations in 1928.—For Chino Mines a total of 3,596,144 dry tons of ore was milled through the Hurley concentrator during the year, equivalent to a daily average of 9,852 tons. The cost of milling, exclusive of depreciation and taxes but including all other expenses, was 55.4 cents a ton.

Other improvements and additions.—At Chino Mines the installation of a 7,500 kw. turbogenerator set and its auxiliaries was completed, this unit being put into operation in September, and some work is being done in the boiler plant to equip the boilers for burning pulverized coal. This alteration was undertaken in order to decrease the cost of power and provide sufficient electrical energy to operate the plant at 15,000 tons of ore daily capacity. At the Santa Rita pit the operation of the power shovels is being changed from steam to electric power. Additional and improved accommodations are being provided for employees of this division also. At Santa Rita a large fireproof dormitory is under construction to replace the one that was burned in the year 1927.

Nevada Consolidated Copper Co.'s production in 1928.—The total quantity of ore produced from the Nevada, Ray, and Chino mines and treated during the year was 11,607,547 tons. Of this total 11,494,762 tons, equivalent to a daily average of 31,492 tons, was treated at the concentrators, and 112,785 tons of crude ore was shipped direct to the smelters. In addition to the company ores as above stated, 941,942 tons of contract and other custom ores were milled and 18,490 tons smelted at the Nevada plants. The average grade of all company material milled was 1.363 per cent copper, and the average recovery in the form of concentrates was 86.56 per cent of the total copper contents, corresponding to 23.60 pounds of copper per ton so treated. The year's total net production of company copper from both concentrates and direct smelting ores was 268,462,629 pounds.

The company derived for the year from the activities and business of its properties in Nevada, Arizona, and New Mexico, a total operating income of \$18,571,561.29. After all proper corporate charges requiring cash outlay, including debenture interest and Federal and other taxes accrued during the year, the net earnings were \$17,027,149.81, corresponding to approximately \$3.50 per share of stock outstanding at the end of the year.

The production of refined marketable copper for the year from all three properties was 268,462,629 pounds, the cost of which, before Federal income taxes but including all other taxes, together with all general expenses and accounting charges for depreciation of plant and equipment, and after crediting the value of gold and silver and miscellaneous earnings, was 8.78 cents per pound of copper, as compared with 10.03 cents per pound, similarly computed, for the year 1927.

Total charges to capital accounts during the year amounted to \$1,337,926.56. These represented chiefly development and the installation of equipment in preparation for mining by underground methods the deep-lying ores below or adjoining open pit areas at Nevada and Chino mines and in the improvement of metallurgical facilities both as to capacity and efficiency.

It is notable in connection with production and costs statements for the year, as compared to those of previous times, that the mines and plants have demonstrated great elasticity in their response to demands for increased output. As the market demand for copper grew from early in the year to the end of it, the output from

the company's properties kept pace uniformly by quarterly periods, the output for the last quarter of the year being 81,226,417 pounds, as compared to 52,576,896 pounds for the first quarter, a gain of 28,649,521 pounds, representing an increased rate of over fifty per cent. Equally noteworthy is the record of declining costs, which has been persistent over a period of about three years regardless of production volume.

At the beginning of the year 1926, prior to the reorganization of the company and enlargement of its business to the present status, the average operating cost of producing copper at the three mines was approximately 10 cents per pound, as compared to 7.58 cents as shown by the report for the fourth quarter of 1928. This total decrease of about 25 per cent for the period stated represents the cumulative improvement which occurred, without exception, although variable in degree, for each successive quarter for the period; and further reductions are to be expected in company with increased production, which should reach a rate of approximately 350,000,000 pounds per annum before the end of 1929.

While, as stated in the operating report, ore reserves were not recalculated at any of the properties, it is definitely known that the commercial grade tonnage available is much larger than that recorded, and this will become increasingly true as constantly declining costs, in company with prevailing tendency toward higher prices for copper, permit profitable treatment of lower-grade material.

Statement of operations of the Nevada Consolidated Copper Co. for the year ended December 31, 1928

Operating revenue:

Copper produced—268,462,629 pounds, at 15.075 cents----	\$40, 470, 217. 94
Gold produced—61,889.9825 ounces, at \$20.545-----	1, 271, 550. 96
Silver produced—256,646.9876 ounces, at 58.173 cents----	149, 299. 02
	41, 891, 067. 92

Operating expenses:

Mining, including stripping and development charge-----	\$9, 958, 820. 47
Ore delivery—mine to mill-----	1, 567, 746. 36
Milling-----	5, 950, 663. 92
Treatment, freight, and refining-----	6, 875, 504. 82
Selling commission-----	335, 526. 88
	24, 688, 262. 45

Profit from operations-----	17, 202, 805. 47
Miscellaneous income—net-----	1, 368, 755. 82

Total income-----	18, 571, 561. 29
-------------------	------------------

Charges against income:

Depreciation-----	\$1, 676, 647. 49
Plant and equipment retirements-----	149, 398. 67
Federal income tax and other charges-----	1, 379, 812. 83
	3, 205, 858. 99

Net income before interest-----	15, 365, 702. 30
Interest on debentures-----	164, 598. 65

Net income to surplus account-----	15, 201, 103. 65
------------------------------------	------------------

SURPLUS FROM OPERATIONS

Balance—December 31, 1927-----	12, 574, 943. 64
Net income for year 1928 (without deduction for depletion)---	15, 201, 103. 65

27, 776, 047. 29

Charges against surplus for taxes of prior years..	\$13, 168. 52
Distribution to shareholders-----	7, 892, 684. 00
	7, 905, 852. 52

Balance—December 31, 1928-----	19, 870, 194. 77
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In 1928 the Empire Zinc Co.'s 250-ton magnetic separation mill at Hanover remained idle (as in 1927), but the company's flotation mill, built and operated in 1927, continued operation on zinc tailings from the magnetic mill. The flotation product—zinc concentrates—was shipped to the company's zinc-oxide plant at Canon City, Colo. The Black Hawk Consolidated Mines Co. completed its 145-ton selective flotation mill 1 mile south of Hanover, alongside the railroad, and 400 feet from the Combination mine shaft. This new mill was operated for 100 days in 1928 on lead-zinc sulphide ore from the company's Combination mine and custom ore from the Three Brothers mine. The equipment consists of 1 jaw crusher, 1 Symons cone crusher, 1 Marcy ball mill, 1 Dorr classifier, 7 Southwestern Air Lift flotation machines, 1 American 3-leaf 6-foot filter, and 2 Dorr thickening tanks. Wright ⁸ says the heads average 2.37 ounces silver, 2.04 per cent lead, 0.44 per cent copper, and 12.04 per cent zinc.

The holdings of the Hanover Copper Co. and of the Grant County Copper Co., near Hanover, which were purchased by the Peru Mining Co. early in 1927 and reopened in June, 1927, were sufficiently developed by March, 1928, to furnish lead-zinc-copper-silver-gold sulphide ore to the company's 100-ton selective flotation mill, completed early in 1928, at Wemple, 3½ miles northwest of Deming. The distance from the mine to the mill is 50 miles by railroad. During the year the mill capacity was increased to 200 tons in 24 hours, and custom ore was accepted from the Ground Hog mine. The equipment of the mill consists of 1 Universal crusher, 1 Symons cone crusher, 2 ball mills, 2 Dorr classifiers, 6 Southwestern Machinery Co.'s flotation machines, 2 Mineral Separation flotation machines, 3 filters, 5 Dorr thickening tanks, and a sampler.

The Lucky Bill mine, near Bayard, was operated to July 1, 1928, by Stauber & Wright, lessees, and from July 1 to December 31 by the owners, the Black Hawk Consolidated Mines Co. The ore from the Lucky Bill, a mixed silver-lead and silver-copper sulphide, was all shipped direct to the El Paso smelter, where it was distributed either to the copper or to the lead plant, according to grade.

The Bell Mining Co. shipped one car of copper-lead-silver smelting ore and one lot of lead-copper-silver ore from Bayard. R. R. Foster shipped 9,000 tons of copper slag from the old smelter dump of the Hedley Gold Mines Co., 3 miles west of Black Hawk siding, south of Hanover. In addition to the lead-zinc sulphide ore shipped, the Hayward-Richards Leasing Co. and the Asarco Mining Co. shipped mixed oxidized and sulphide copper-silver-lead and lead-silver-copper smelting ore from the Ground Hog mine, at Vanadium. The Hanover Bessemer Iron & Copper Co. shipped about 200,000 short tons of magnetite ore from its mines ⁹ at Fierro to the Colorado Fuel & Iron Co. and intermittently shipped copper oxidized smelting ore and copper iron slag to El Paso, Tex. This group of mines is opened by a 6,000-foot adit. No reduction or separation plant is used for the copper ores, and the iron ore was all hand picked until December, when the 1,200-ton (24 hours) magnetic separation mill was remodeled and put into operation. The equipment of the remodeled mill

⁸ Wright, Ira L., *The Small Mill Problem*: Eng. and Min. Jour., Jan. 26, 1929, p. 150.

⁹ Paige, Sidney, *The Hanover Iron-Ore Deposits, N. Mex.*; Contributions to Economic Geology, 1908, Part 1: U. S. Geol. Survey Bull. 380, 1908, pp. 199-214.

consists of 1 Allis Chalmers No. 9 and 1 No. 7½ gyratory crusher, 2 El Paso Foundry 36 by 60 inch shaking screens, 1 Traylor electric vibratory 36 by 60 inch screen, and 4 Ding minus ¼ inch to minus 2½ inch magnetic separation machines of the 3-belt type.

One-half car of copper-gold-silver sulphide smelting ore was shipped from the Taff-Tidalwave group, at Fierro. Lessees on the Modoc-Emma group at Fierro shipped siliceous oxidized copper smelting ore to El Paso and to Douglas. Several cars of copper-silver-gold sulphide ore were shipped to El Paso from the Dewey-Schley group, at Fierro.

Mine production of gold, silver, copper, lead, and zinc in Central district, Grant County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1904.....	21,048	\$5,582	282	3,264,208	11,977	-----	\$424,080
1905.....	20,252	-----	8	3,179,206	-----	96,424	501,650
1906.....	39,155	4	2,524	3,075,001	235,070	99,656	614,673
1907.....	57,079	5,659	36,813	4,994,575	855,358	73,729	1,078,555
1908.....	41,852	777	296	3,994,502	29,122	251,070	541,231
1909.....	41,456	816	1,380	3,348,808	23,256	203,278	448,856
1910.....	37,008	-----	404	2,679,630	155	1,285,500	409,955
1911.....	45,584	104	8,673	1,413,189	605,978	290,122	225,156
1912.....	1,136,290	998	29,586	29,512,812	2,172,676	2,205,824	5,138,779
1913.....	1,948,471	9,697	12,500	51,695,656	331,440	2,187,266	8,167,144
1914.....	1,934,020	102,971	42,971	55,222,874	365,079	3,669,513	7,672,759
1915.....	2,395,795	102,379	73,267	66,581,366	1,542,234	5,628,870	12,561,729
1916.....	3,134,791	133,962	116,953	74,223,606	2,122,797	7,275,575	19,592,956
1917.....	3,668,289	138,873	121,386	82,200,421	2,250,337	7,398,853	23,627,822
1918.....	3,908,816	128,577	111,175	77,547,300	2,857,887	8,826,967	20,400,099
1919.....	1,789,083	57,280	34,503	40,358,634	1,283,642	4,299,658	7,984,543
1920.....	1,882,172	68,962	26,190	44,400,088	925,513	6,134,593	8,838,068
1921.....	362,331	10,439	9,688	9,138,442	4,422	95,000	1,203,935
1922.....	1,426,783	24,537	11,326	28,408,184	352,640	1,333,440	3,966,369
1923.....	2,885,711	68,108	29,264	54,374,770	1,311,141	13,017,000	9,062,131
1924.....	2,859,688	71,121	33,200	66,824,015	1,183,626	16,921,000	10,045,216
1925.....	3,159,167	97,299	76,547	63,812,280	2,363,260	15,033,000	11,269,879
1926.....	3,633,821	109,335	86,963	75,219,200	2,611,100	14,327,000	11,977,701
1927.....	3,087,823	98,963	85,963	66,971,008	1,907,476	10,076,000	9,685,941
1928.....	3,723,753	113,507	143,993	80,238,820	2,359,155	15,089,000	12,809,393
Total, 1904-1928.	43,240,238	1,349,950	1,100,860	997,683,595	27,705,341	135,821,338	188,248,620

Chloride Flat district (Silver City).—No silver-lead ores were mined in 1928 from the Chloride Flat district, adjoining Silver City, but iron-manganese ore¹⁰ continued to be shipped from the Boston Hill group, Clan-Seven Sisters-Legal Tender group, and from the Silver Spot group. This ore was shipped to the steel furnaces of the Colorado Fuel & Iron Co., Pueblo, Colo.

Eureka (Hachita) district (see also Eureka district, Hidalgo County).—The American Group flotation mill, located at the mine 8 miles west of Hachita, was idle in 1928, but several cars of lead-silver smelting ore were shipped from the mine.

Gold Hill district.—No production was made in 1928 from the Gold Hill district, from which for several years past has come amalgamation gold and silver bullion from small operations on surface outcrops and shallow openings.

*Pinos Altos district.*¹¹—The Calumet-New Mexico gravity-concentration mill was operated for a short time in 1928, producing two

¹⁰ Jones, E. L., jr., Deposits of Manganese Ore in New Mexico; Contributions to Economic Geology, 1919, Part I: U. S. Geol. Survey Bull. 710, 1920, pp. 37-60; Wells, E. H., Manganese in New Mexico: New Mexico State School of Mines Bull., 1918.

¹¹ Paige, Sidney, The Ore Deposits near Pinos Altos, N. Mex.; Contributions to Economic Geology, 1910, Part I: U. S. Geol. Survey Bull. 470, 1911, pp. 109-125.

cars of lead-silver-gold concentrate and one car of zinc-lead-copper-silver-gold concentrate. Other production from lode mines came from a small lot of dry gold ore from the Chapin prospect, a car of lead-silver ore from the Chapman & Clark prospect, and several cars of low-grade copper-silver-gold ore from the U. S. Group, all of which was shipped to smelters. Surface deposits at Pinos Altos yielded, chiefly after heavy rains, small pannings of placer gold, totaling 64.41 crude ounces, which upon melting at the Denver Mint was reduced to 59.80 crude ounces, averaging 0.746 in gold fineness and 0.232 in silver fineness.

Mine production of gold, silver, copper, lead, and zinc in Pinos Altos district, Grant County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold		Silver	Copper	Lead	Zinc	Total value
		Lode	Placer					
	<i>Short tons</i>			<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1904.....	4, 719	\$49, 660	\$7, 750	37, 229	104, 069	2, 653	-----	\$92, 438
1905.....	6, 348	31, 442	10, 943	39, 585	103, 469	-----	160, 779	92, 159
1906.....	14, 074	89, 674	2, 290	83, 566	328, 788	-----	-----	212, 245
1907.....	14, 841	78, 723	3, 782	65, 862	322, 195	-----	-----	190, 413
1908.....	1, 451	8, 548	1, 479	8, 941	34, 514	3, 953	-----	19, 488
1909.....	38	2, 083	3, 584	1, 377	6, 200	418	-----	7, 207
1910.....	70	1, 372	2, 494	223	269	2, 226	-----	4, 119
1911.....	355	1, 406	4, 043	5, 616	3, 232	4, 063	16, 773	9, 968
1912.....	6, 169	7, 973	2, 551	15, 864	96, 507	50, 289	929, 176	102, 581
1913.....	3, 643	29, 162	1, 646	28, 276	100, 555	83, 067	366, 056	87, 626
1914.....	3, 686	114, 181	121, 560	23, 256	129, 587	29, 994	48, 840	169, 497
1915.....	7, 024	31, 823	1, 979	19, 884	377, 463	130, 638	454, 710	172, 463
1916.....	46, 471	11, 775	2, 009	17, 816	122, 716	152, 696	6, 741, 925	969, 649
1917.....	45, 993	7, 731	3, 153	10, 803	49, 945	80, 989	5, 556, 892	607, 189
1918.....	28, 983	1, 972	672	2, 243	12, 227	40, 028	3, 013, 802	285, 005
1919.....	2, 912	5, 044	1, 074	2, 524	14, 452	20, 906	267, 671	32, 281
1920.....	1, 444	3, 168	554	2, 000	2, 456	40, 325	43, 247	13, 083
1921.....	-----	-----	2, 368	37	-----	-----	-----	2, 405
1922.....	7, 880	19, 142	2, 079	55, 820	26, 193	673, 847	-----	117, 639
1923.....	2, 968	12, 988	1, 300	17, 404	68, 129	90, 471	44, 000	47, 899
1924.....	387	2, 164	1, 042	1, 979	4, 320	62, 135	-----	10, 069
1925.....	407	95	529	2, 287	430	96, 550	-----	10, 672
1926.....	3, 488	5, 532	639	4, 578	8, 400	152, 800	170, 000	35, 178
1927.....	5, 219	5, 332	693	4, 591	12, 206	142, 492	170, 000	27, 524
1928.....	1, 229	856	923	812	1, 000	27, 466	18, 000	5, 089
Total, 1904-1928..	209, 749	521, 846	81, 136	452, 573	1, 929, 322	1, 888, 006	17, 961, 871	3, 323, 886

¹ Output from surface lode mines included with placer. Only a small quantity recovered by actual placer methods. Fineness so similar, separation not practicable.

Steeple Rock district (16 miles east of Duncan, Ariz.).—One car of copper-silver ore was shipped in 1928 from the Carlisle group to the Copper Queen copper smelter at Douglas, Ariz. This group was unwatered in 1927.

Swartz (or Carpenter) district.—The old Royal John mill, 28 miles east of Santa Rita, remodeled in 1927 to a flotation plant, was operated from July to December, 1928, by the Asarco Mining Co., Black Range unit. The products were zinc-lead-copper-silver-gold concentrates and lead-copper-silver concentrates. The equipment of the mill consists of 1 Blake crusher, 1 Symons disk crusher, 1 Hardinge mill, two 15-foot and two 9-foot Forrester flotation machines, and two 6 by 6 foot Devereau agitation tanks.

White Signal district.—A 1-ton lot of copper-silver-gold sulphide ore was shipped to the El Paso smelter from the H. H. R. prospect.

GUADALUPE COUNTY

I. J. Stauber continued to ship oxidized copper ore from a surface deposit in sections 6 and 7, T. 7 N., R. 20 E. of the New Mexico principal meridian. The ore carries 4.52 per cent copper, 0.3 ounce silver, 82 per cent silica, 1.5 per cent combined iron and manganese, 0.2 per cent sulphur, 1.7 per cent alumina, and 0.5 per cent CaO. The mine is developed by shallow shafts averaging 27 feet, and the ore is extracted by drifts, leaving about 30 per cent as pillars.

HIDALGO COUNTY

*Eureka district (Hachita) (see also Eureka district, Grant County).—*The Apache Leasing Co. in 1928 continued to ship lime rock from the Apache mine, south of Hachita, to the El Paso smelter. This ore in 1928 carried 4.22 ounces of silver to the ton and 1.6 per cent of copper. In addition to the lime rock, several cars of ore carrying 12.7 ounces silver and 10 per cent lead to the ton were shipped. One car of lead-silver ore was shipped to El Paso from the By Chance prospect by the La Central Mining Co.

*Fremont district (Hachita) (see also Fremont district, Luna County).—*Assessment work was done on the Volney group in 1928.

*Gillespie (or Red Hill) district (Hachita).—*The Red Hill district is named after the Red Hill mine, 28 miles southwest of Hachita. The shaft on the Red Hill mine is 476 feet deep. No work was done in 1928.

*Lordsburg district (including Pyramid and Virginia or Shakespeare districts).—*Shipments of highly siliceous gold-silver-copper ore for use in the copper converter linings of smelters at Douglas, Ariz., continued at approximately the same rate as in 1923 to 1927. The Eighty-Five mine of the Calumet & Arizona Mining Co. continued as the main producer of the district. Other producers in 1928 were the Anita No. 1, Ada-Etta, Battleship, Bonney-Shoofly-Lone group, and Robert E. Lee. The annual report of the Calumet & Arizona Mining Co., New Cornelia Copper Co., and Verde Central Mines (Inc.) for the year ended December 31, 1928, says of the Eighty-Five branch of the Calumet & Arizona Mining Co.:

During the year 1928 a total of 9,355.5 feet of development work was completed as compared with 6,525 feet in the preceding year, an increase of 2,830.5 feet. In detail the work was as follows: Drifting, 5,664.5 feet; crosscutting, 2,441.5 feet; raising, 984.5 feet; sinking, 265.0 feet; total, 9,355.5 feet.

Of this total amount of development work, 16.5 per cent was done on the 650 level, where ore was proved to extend to a greater distance in both an easterly and westerly direction than had been known previously.

On all levels from the 650 level to the 1,650 level the drifts were advanced along the vein in a westerly direction as fast as conditions would permit.

High-grade ore was developed on the 650, 900, 1,250, 1,350, 1,500, and 1,650 levels during the first six months of the year. The development work for the last six months has not been so favorable on account of faulted areas that are composed of practically barren andesite.

A new vertical 3-compartment shaft, known as the Jim Crow, located about 2,350 feet west of the main shaft, was started in November and has reached a depth of 265 feet. Connections have been made with the 200 level from the main shaft. The Jim Crow shaft is being sunk for the purpose of opening up the western portion of our property and to provide another opening to our extensive mine workings.

Ore mined in 1928 was 93,672 wet tons; ore shipped from leases was 80 wet tons; and clay shipped from clay pit was 1,016 wet tons.

The average grade of the ore shipped to the Calumet & Arizona smelter at Douglas for the year was 2.74 per cent copper, as compared with 2.33 per cent copper in 1927.

Water pumped for the year has gradually increased from 300 gallons per minute to the present average of 350 gallons per minute.

The mine was closed down for a total of 40 days during the year for shaft repairs. The main shaft was retimbered for a distance of 420 feet.

A Sullivan WN-4 Angle Compound Compressor with an output of 2,600 cubic feet per minute was installed during July and August.

A double-drum Allis Chalmers electric hoist and belt-driven Ingersoll Rand Compressor were installed at the Jim Crow shaft and a power line was constructed from there to the power plant.

A double dwelling house, a boarding house, a small rooming house, and nine apartments for employees were built during the year besides extensive repairs on many of the older buildings.

*Mine production of gold, silver, copper, and lead in Lordsburg district, Hidalgo County, N. Mex., 1904-1928, in terms of recovered metals*¹

Year	Ore	Gold	Silver	Copper	Lead	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	
1904-----	250	\$1,208	2,580	18,200	12,000	\$5,550
1905-----	366	10	7,584	48,000	-----	12,124
1906-----	1,743	5,168	27,261	212,601	-----	64,737
1907-----	5,645	8,761	31,303	463,335	10,522	122,646
1908-----	7,532	10,617	9,889	259,079	11,373	50,534
1909-----	10,690	25,983	50,154	589,969	8,862	129,140
1910-----	29,220	59,798	130,324	1,627,591	19,662	337,742
1911-----	46,139	106,648	182,448	2,455,336	2,157	510,359
1912-----	55,340	144,859	275,251	3,155,585	4,562	835,015
1913-----	31,284	55,234	154,779	1,601,461	14,572	397,588
1914-----	38,964	101,080	232,647	2,614,674	30,049	578,658
1915-----	92,093	222,848	374,325	3,890,365	28,723	1,094,795
1916-----	118,966	267,148	373,074	4,755,179	30,478	1,684,508
1917-----	99,532	245,607	295,443	4,261,956	41,442	1,656,130
1918-----	55,015	130,858	153,236	2,214,996	17,831	832,464
1919-----	77,002	175,008	242,733	3,516,457	53,264	1,103,753
1920-----	55,307	153,461	182,000	2,695,674	98,312	855,710
1921-----	11,593	22,987	35,119	579,295	13,134	133,426
1922-----	61,291	114,911	107,511	3,216,585	102,291	662,287
1923-----	96,587	216,554	141,538	4,314,122	46,185	970,024
1924-----	88,472	192,203	113,591	4,927,878	40,412	917,094
1925-----	108,219	222,823	126,781	5,064,140	69,700	1,035,981
1926-----	97,420	241,954	126,909	4,762,750	73,400	993,802
1927-----	93,406	197,333	77,155	3,933,496	46,381	759,290
1928-----	91,289	217,548	104,653	4,625,347	19,638	945,959
Total, 1904-1928-----	1,373,365	3,140,609	3,558,288	65,804,071	794,950	16,689,316

¹ In reports prior to 1920 the production for the Lordsburg district will be found under Grant County.

San Simon district (Steins).—The 100-ton flotation mill built in 1927-28 at the Carbon Hill holdings was operated part time in 1928. The product was lead concentrates. Several cars of silver-lead smelting ore were shipped from the Silver Hill property in 1928. The Granite Gap property was unwatered in the first six months of 1928, but the lease was abandoned shortly afterwards. A new lessee took over the property October 1, 1928.

LINCOLN COUNTY

No production was made in 1928 from the Jicarilla and Whiteoaks districts, former producers. Small outputs were made from the Nogal and Red Cloud districts.

Nogal district.—One-half carload of silver-lead ore from the Grizzly-Handy group, one small lot of copper-silver ore from the Craven prospect, and one small lot of dry silver ore from the High Towers

group were shipped in 1928 to the El Paso smelter from the Nogal district.

Red Cloud or Gallinas Mountains district.—In the course of surface development work a new lessee shipped one car of silver-lead ore from the Red Cloud-Deadwood group, $7\frac{1}{2}$ miles from Gallinas station, on the Southern Pacific Railroad. This property is opened by a 200-foot shaft and 1,500 feet of drifts.

LUNA COUNTY

Cooks Peak district (north of Deming).—The Cooks Peak district, once a relatively prominent producing district of Luna County, was idle in 1928.

Mine production of gold, silver, copper, lead, and zinc in Cooks Peak district, Luna County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1904.....	1,078		4,401		576,795		\$27,355
1905.....	846		5,199		463,956		24,977
1906.....	1,133		7,519		627,544		40,883
1907.....	811	\$12,713	4,739		592,151		47,225
1908.....	253		1,009		127,535		5,891
1909.....	695		4,317	46	597,488		27,943
1910.....	457		1,917	47	242,137		11,695
1911.....	45		200		32,638		1,575
1912.....	927		960		142,680	433,129	36,897
1913.....	1,271		1,248	1,395	255,901	695,697	51,189
1914.....	1,995	68	2,423	2,181	381,324	793,588	57,043
1915.....	1,352	7	432		64,382	647,210	83,506
1916.....	2,562		433		56,275	1,390,119	190,444
1917.....	2,330	20	3,602	99	272,140	1,067,853	135,340
1918.....	1,252	33	1,947	3,150	156,549	463,445	56,046
1919.....	122		745	941	26,473	31,575	4,717
1920.....	136	10	1,322	2,223	52,738	21,098	7,788
1921.....							
1922.....	81		72	1,130	9,087	24,228	2,106
1923.....	8		15	13	1,988		153
1924.....	454	70	1,658	573	152,199		13,432
1925.....	1,740	109	2,657	1,200	416,230	119,300	47,402
1926.....	319		492	242	106,500	42,000	12,011
1927.....	1,006	257	1,335	367	162,238		11,283
1928.....							
Total, 1904-1928.....	20,873	13,287	48,642	13,607	5,516,948	5,729,242	896,901

Florida Mountains district.—Small development work was all that was done in the Florida Mountains district, south of Deming.

Fremont district (Hachita) (see also Fremont district, Hidalgo County).—Assessment work was done at the Keno group.

Tres Hermanas district ¹² *(Columbus).*—Assessment work was done at several properties in the Tres Hermanas district, north of Columbus.

Victorio district (Gage).—One car of lead-silver smelting ore was shipped in 1928 from the Chance group, near Gage.

¹² Lindgren, Waldemar, The Tres Hermanas Mining District, N. Mex.; Contributions to Economic Geology, 1908, Part I: U. S. Geol. Survey Bull. 380, 1908, pp. 123-128.

Mine production of gold, silver, copper, lead, and zinc in Victorio district (Gage), Luna County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1904	274	\$1,695	2,047		76,465		\$6,170
1905							
1906	620	413	2,876		186,000		12,971
1907	1,200	992	3,600		408,000		24,992
1908							
1909	183	290	2,460	1,069	85,418		5,381
1910	22	3	267		21,318		1,085
1911	180	104	883	1,598	66,250		3,753
1912	2,123	5,687	23,305		684,867	7,865	51,382
1913	3,895	11,085	40,416	58	902,781		75,227
1914	132	158	552		35,599		1,851
1915	216	457	1,476	2,320	53,958		4,147
1916	1,804	3,535	8,436		381,000		35,375
1917	1,505	5,191	11,301	220	428,907		51,449
1918	1,631	8,171	14,358		323,493		45,497
1919	1,728	4,926	10,438	538	356,775		35,626
1920	1,331	6,661	10,167	1,641	298,113		41,894
1921	676	1,488	4,709		144,467		12,698
1922	158	372	583		28,622		2,529
1923	468	1,300	2,195	1,028	64,930		7,796
1924	285	132	485		47,975		4,295
1925	609	823	2,833	1,000	116,600		13,075
1926	129	149	633		22,500		2,344
1927	28	45	224		7,398		638
1928	40	85	188		9,000		717
Total, 1904-1928	18,237	53,762	144,432	9,472	4,750,436	7,865	440,892

OTERO COUNTY

Orogrande district.—Elmer & Strong, lessees on the old By Chance mine, at Orogrande, shipped 2,753 tons of gold-silver-copper-iron mixed sulphide and oxidized ore in 1928 to the El Paso smelter. The average analysis of the ore was reported as 38 per cent silica, 20 per cent iron, 2 per cent manganese, 7 per cent sulphur, 2 per cent Al_2O_3 , 20 per cent CaO , and 2 per cent MgO .

Mine production of gold, silver, copper, and lead in Orogrande district, Otero County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold		Silver (lode and placer)	Copper	Lead	Total value
		Lode	Placer				
	<i>Short tons</i>			<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	
1904	170	\$1,569	\$1,050	164	14,400		\$4,557
1905	20	41	1,036	93	3,600		1,696
1906	78	228	195	163	11,166		2,689
1907	11,319	14,711	100	1,829	555,580		127,134
1908	21,901	34,215	1,475	4,205	710,780		131,742
1909	143	157	100	29	6,354		1,098
1910	536	2,559	6,022	2,007	38,858	5,841	14,857
1911	770	6,718		680	10,406	739	8,412
1912	2,553	11,005	2,034	1,011	119,740		33,418
1913	15,822	49,805	42	6,444	597,580	1,911	146,448
1914	11,069	38,459		5,376	387,211	2,027	93,010
1915	14,930	54,974		6,150	853,257		207,412
1916	20,195	39,504	305	7,403	1,077,492	638	309,787
1917	15,558	23,504	737	4,514	731,894		227,768
1918	6,210	5,096		2,048	253,405		69,735
1919	205	74		25	4,382		917
1920							
1921	500	5,230		32			5,262
1922							
1923	68	366		190	666	14,286	1,620
1924	499	21		397	4,046	129,286	11,160
1925	217	715		75	13,300		2,656
1926							
1927	372	396		60	7,847		1,458
1928	2,753	4,104		559	70,368		14,564
Total, 1904-1928	125,828	293,451	13,096	43,454	5,472,332	154,728	1,417,400

High Rolls district.—Corrie & Warnock operated the Courtney property from July to November 15, 1928, and shipped several cars of copper ore. The Courtney is opened by a 100-foot shaft.

Sacramento Mountains district (Alamogordo).—Stewart & Holmes, lessees on the Alamo group, east of Alamogordo and 10 miles from Oliver Lee station on the Southern Pacific Railroad, shipped nearly 1,000 tons of low-grade silver-lead ore to El Paso.

SANDOVAL COUNTY

The Burnett Mining Co. continued development work at the Spanish Queen group, near Jemez Springs, and shipped two cars of copper ore to El Paso.

SAN MIGUEL COUNTY

First set in operation January 20, 1927, the American Metal Co.'s 600-ton selective flotation mill, in Alamitos Canyon, 6 miles by road from Glorieta station and 4 miles by railroad spur from Fox station on the Atchison, Topeka & Santa Fe Railroad, continued in operation throughout 1928 with only minor shutdowns for repairs, the longest idle period being due to a breakdown in the aerial tram. The mill is connected by a 12-mile tram with the Pecos mine (variously known since 1878 as the Cowles, Hamilton, or Goodrich-Lockhart mine, and as the Katydid, Evangeline, and other claims) at the junction of Pecos River and Willow Creek. The post office at the mine is called Tererro. The ore minerals are sphalerite, galena, chalcopyrite, and pyrite, and the gangue is sheared micaceous diorite.

One of the chief problems in milling is to remove the sericite and talc. The actual heads in 1928 averaged 0.106 ounce gold, 3.39 ounces silver, 3.77 per cent lead, 1 per cent copper, and 16.24 per cent zinc. From 201,013 dry tons treated in 1928 were made 55,483 tons of zinc concentrates (averaging 0.066 ounce gold, 3.58 ounces silver, 1.60 per cent lead, 1.45 per cent copper, 7.70 per cent lead, and 50.4 per cent zinc) and 16,448 tons of lead-copper concentrates (averaging 0.755 ounce gold, 21.64 ounces silver, 34.74 per cent lead, 4.63 per cent copper, 13.7 per cent iron, and 12.5 per cent zinc).

The lead concentrates were shipped in 1928 to the American Smelting & Refining Co.'s lead plant at El Paso. The zinc concentrates were shipped to the Blackwell Zinc Co. (American Metal Co.) natural-gas retort plant at Blackwell, Okla., and to the American Zinc & Chemical Co. (American Metal Co.) at Langeloth, Pa. Zinc residues from Blackwell went to El Paso, Tex., and from Langeloth to Chrome, N. J.

The ore is crushed at the mine by one 30 by 18 inch jaw crusher, two 6 by 10 inch gyratory crushers, and one set of 54 by 20 inch Garfield rolls. The mill is equipped with 3 No. 75 Marcy mills, 3 Dorr Duplex 6-foot classifiers, 24 standard Wilfley tables, 120 M. S. Sub. A. 18-inch flotation cells, three 8 by 12 foot Oliver filters, and three 40 by 10 foot Dorr thickening tanks.

The power for both mine and mill is electric, made at the 3,000-kilowatt (two 1,500-kilowatt units) steam turbine plant adjacent to the mill. The fuel used is powdered New Mexico bituminous coal. Water for the mill is pumped from Pecos River, and the tailings from the mill are caught in a dam in Alamitos Canyon.

The mine is opened by a 618-foot vertical shaft and by 13,724 feet of drifts and crosscuts, of which 82 feet of shaft and 9,571 feet of drifts

and crosscuts were done in 1928. The mining method includes both the cut-and-fill system and square sets. Native timber from the forest reserve is used for timbering.

SANTA FE COUNTY

Cerrillos district.—One car of lead-silver ore was shipped to the El Paso smelter from the Cash Entry mine. W. H. and R. B. Paul continued operation of the Evelyn Gold Copper group, 5½ miles north of Waldo station, until April 1, 1928, but made no shipments. Later in the year V. Carl Grubnau leased the property and shipped several cars of copper-gold-silver oxidized ore to the El Paso smelter.

Mine production of gold, silver, copper, lead, and zinc in Los Cerrillos district, Santa Fe County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold		Silver (lode and placer)	Copper	Lead	Zinc	Total value
		Lode	Placer					
	Short tons			Fine ounces	Pounds	Pounds	Pounds	
1904-1906.....								
1907.....			\$111					\$111
1908.....			217					217
1909.....	2,821	\$418	602	2,285	1,093	213,558	4,426	11,772
1910.....	4,617	499	1,757	3,300	5,150	262,023	74,759	20,258
1911.....	51	343	101	1,915	4,494	11,178		2,524
1912.....	752	8	195	1,040	8,670	12,511	10,565	3,566
1913.....								
1914.....	287	60		779	7,575	52,948	89,860	8,146
1915.....	700	127		426	1,766	50,638	14,556	4,837
1916.....	2,546	148		2,175		166,304	334,321	57,853
1917.....	3,118	23		142	2,579	17,779	512,628	54,661
1918.....	172					11,000	94,572	9,387
1919-1921.....								
1922.....	40					8,800	19,840	1,615
1923-1925.....								
1926.....	807	4,343		1,011	41,800	24,500		12,786
1927.....	1,644	6,572		1,120	71,771	8,635		17,153
1928.....	300	870		205	12,174	2,466		2,886
Total, 1904-1928..	17,855	13,411	2,983	14,398	157,072	842,340	1,155,527	207,772

La Bajada district.—One small lot of copper-silver ore was shipped from the La Bajada prospect.

New Placers district (Golden, San Pedro).—The Carnahan 50-ton selective flotation mill was continued in operation for a short time in 1928 on the coarsely crystalline sphalerite-galena ore of the Amazon-Anaconda-Lincoln-Lucky group, near San Pedro. The products were high-grade lead concentrates carrying a little gold and 20 ounces silver to the ton, nearly free of zinc, but relatively poor zinc concentrates containing about 5 per cent of lead and 3 ounces of silver to the ton. One car of copper-silver-gold mixed sulphide and oxidized ore was shipped to El Paso from the San Francisco property. Several sets of lessees on the dumps of the San Pedro mine shipped 2,200 tons of copper-silver-gold ore to El Paso. The ore is hauled 12½ miles northwest to Hagan railroad station. This mine is part of the property of the Santa Fe Gold & Copper Co., which owns 33,479 acres of lands, of which 279 acres are patented copper claims. When worked

by the company from 1900 to 1917 the copper mine was opened by a 200-foot shaft and a 1,600-foot adit.

Mine production of gold, silver, copper, lead, and zinc in New Placers district (Golden, San Pedro), Santa Fe County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold		Silver (lode and placer)	Copper	Lead	Zinc	Total value
		Lode	Placer					
	<i>Shorttons</i>			<i>Fine ounces</i>	<i>Pounds 2, 308</i>	<i>Pounds</i>	<i>Pounds</i>	
1904	170	\$1, 292	\$4, 135	42				\$5, 722
1905	180	2, 241	4, 002	53				6, 269
1906	128	7, 143	6, 737	17, 635	1, 231, 260			13, 916
1907	21, 338	16, 748	1, 120	6				275, 759
1908	7	242	1, 572	10				1, 817
1909	10	453	1, 215	59				1, 673
1910	122	3, 378	2, 505	717	12, 150			5, 915
1911	69	982	2, 258	13, 138	801, 893			5, 139
1912	14, 583	10, 208	1, 107	22, 076	1, 798, 769	794		151, 706
1913	29, 800	26, 746	129	4, 944	285, 786			319, 053
1914	23, 297	8, 980	1, 312	23, 945	1, 703, 091			51, 036
1915	27, 013	41, 973	1, 567	29, 696	2, 153, 610			353, 721
1916	40, 137	66, 106	3, 112	6, 739	396, 828			618, 646
1917	7, 024	7, 129	2, 155	5, 244	220, 846	17, 479		123, 171
1918	3, 743	3, 981	313	642	3, 414	16, 623		65, 328
1919	125	1, 484		46	2, 598			3, 719
1920	111	1, 130		5			37, 555	4, 700
1921			2, 466	27	2, 003			2, 471
1922	9	20	224	298	-23, 102			541
1923	105	717	970	1, 788	143, 152	5, 787	14, 400	5, 328
1924	569	2, 553	294	10, 275	199, 770	249, 800	170, 000	24, 197
1925	5, 984	5, 321	519	37, 651	136, 000	1, 053, 166	1, 234, 000	75, 991
1926	6, 952	4, 061	197	54, 037	46, 748	2, 199, 490	2, 446, 000	223, 595
1927	15, 248	4, 719	2, 960	6, 530	243, 042	96, 069	145, 000	339, 554
1928	3, 252	3, 322						56, 557
Total, 1904-1928	199, 976	220, 929	40, 869	235, 603	9, 406, 370	3, 639, 208	4, 046, 955	2, 735, 424

SIERRA COUNTY

Apache, Cuchillo Negro district (Chloride).—A car of lead-silver concentrates carrying also zinc was shipped from the Cuchillo property to the lead plant of the Copper Queen smelter, Douglas, Ariz., and a car of dry silver-gold ore from the Republic mine was shipped to El Paso.

Kingston district.—One lot of lead-silver ore was shipped to El Paso from the Little Buck property.

Las Animas district (Hillsboro).—One car of gold-silver-copper ore was shipped to El Paso from the Empire-Bonanza mine, and one car of dry gold ore was shipped to El Paso from the Garfield property.

Macho district (Lake Valley).—Several cars of lead-silver-gold ore were shipped by a lessee on the Anniversary-Bull Dog group on Macho Creek, 10 miles northwest of Nutt station.

Pittsburg district (Hot Springs).—Several lots of low-grade material carrying a little silver and copper and one car of low-grade material carrying a little lead were shipped from the Caballos Mountains, north of Hatch.

Sierra Blanca district.—One car of dry silver ore was shipped to El Paso from the Log Cabin-Cockrobin prospect, 17 miles northwest of Lake Valley.

Mine production of gold, silver, copper, lead, and zinc in Sierra County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold		Silver	Copper	Lead	Zinc	Total value
		Lode	Placer					
	<i>Short tons</i>			<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1904.....	1,295	\$51,617	\$22,979	17,055	16,700	-----	-----	\$86,626
1905.....	3,513	51,164	47,878	8,760	46,664	-----	-----	111,666
1906.....	3,246	16,539	1,509	8,102	5,995	-----	-----	24,714
1907.....	700	7,629	595	2,250	5,425	9,543	-----	11,300
1908.....	680	16,039	1,979	8,589	12,874	6,075	-----	24,524
1909.....	4,294	10,450	-----	25,698	25,838	49,023	-----	29,280
1910.....	8,306	11,113	584	15,778	2,448	11,274	-----	21,024
1911.....	5,036	26,962	823	16,487	5,374	28,088	-----	38,459
1912.....	252	2,597	1,546	11,236	8,988	21,001	-----	13,481
1913.....	269	434	423	2,529	2,568	32,685	-----	4,221
1914.....	98	1,305	442	3,982	14,436	5,743	-----	6,093
1915.....	438	1,079	1,757	316	2,228	24,617	7,492	5,472
1916.....	935	1,468	-----	2,138	14,427	126,609	7,045	16,104
1917.....	619	1,470	331	8,712	11,828	80,116	-----	19,099
1918.....	801	568	-----	18,536	42,053	25,915	-----	31,331
1919.....	4,041	3,948	-----	67,658	31,661	49,679	-----	88,247
1920.....	6,957	15,896	-----	117,089	43,826	84,264	-----	158,328
1921.....	3,856	1,323	-----	77,366	1,395	40,934	-----	80,711
1922.....	9,965	2,708	-----	136,842	38,771	8,746	-----	145,265
1923.....	6,441	6,443	-----	80,814	61,469	12,842	-----	82,645
1924.....	42	527	-----	1,297	3,787	4,901	-----	2,284
1925.....	2,545	1,825	-----	23,090	6,300	38,930	-----	22,132
1926.....	19,658	4,592	-----	107,973	16,680	298,800	20,500	99,744
1927.....	1,022	8,621	-----	10,300	20,496	123,000	12,000	25,663
1928.....	500	3,485	-----	6,754	5,403	146,448	-----	16,708
Total, 1904-1928....	85,509	249,802	80,846	779,351	447,634	1,229,238	47,037	1,165,121

SOCORRO COUNTY

Magdalena district (Kelly, Magdalena).—The Ozark mine and flotation mill remained idle in 1928. The Black Cloud mill, experimental in 1927 in table concentration and flotation of lead carbonate in a quartz gangue, continued in operation for a short time in 1928. A lessee on the Kelly mine shipped several hundred tons of lead-silver ore to El Paso. One car of zinc carbonate ore was shipped from the Juanita mine and several hundred tons of lead-silver ore from the South Juanita. J. A. McDonald shipped copper-silver sulphide ore to El Paso and zinc-lead sulphide ore to Coffeyville, Kans., from the Nitt mine.

Mine production of gold, silver, copper, lead, and zinc in Magdalena district, Socorro County, N. Mex., 1904-1928, in terms of recovered metals

Year	Ore	Gold	Silver	Copper	Lead	Zinc	Total value
	<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1904-----	27,998	\$154	5,024	3,200	688,209	13,493,835	\$721,257
1905-----	30,411	-----	4,800	320,000	390,000	14,630,051	934,351
1906-----	35,478	-----	2,515	64,560	238,088	17,044,163	1,067,435
1907-----	3,630	13	4,406	24,045	707,981	676,356	85,158
1908-----	6,319	72	460	2,605	16,073	3,325,446	157,631
1909-----	30,724	435	17,925	170,792	3,085,279	12,878,241	860,051
1910-----	42,232	468	65,880	152,181	3,451,228	16,727,870	1,110,529
1911-----	25,840	352	42,773	77,448	2,123,039	9,920,281	694,266
1912-----	22,590	746	32,792	69,532	2,192,792	9,962,478	818,473
1913-----	47,647	3,942	40,212	278,252	2,198,030	13,267,811	911,069
1914-----	51,595	2,265	14,436	214,722	674,205	13,785,176	768,144
1915-----	75,401	488	56,897	1,406,789	2,031,297	18,437,218	2,657,209
1916-----	78,669	2,036	72,877	993,199	4,421,290	19,312,179	3,187,217
1917-----	100,709	2,186	137,114	2,690,381	4,885,210	14,716,745	2,770,878
1918-----	56,295	430	49,835	585,482	3,033,535	11,501,879	1,456,931
1919-----	13,938	10	30,117	599,382	819,566	2,995,740	407,352
1920-----	17,235	-----	18,367	311,663	873,012	3,764,235	452,110
1921-----	412	-----	155	-----	60,711	133,000	9,537
1922-----	8,304	207	6,156	8,063	923,541	3,119,298	236,046
1923-----	10,117	455	15,721	50,388	1,506,829	3,421,000	358,859
1924-----	11,128	199	10,643	94,626	1,636,825	3,823,800	399,219
1925-----	12,356	1,154	25,073	82,800	2,434,600	3,170,000	483,042
1926-----	43,414	606	14,575	56,714	1,400,200	8,013,300	730,654
1927-----	41,702	775	70,478	173,817	1,637,667	4,430,000	450,199
1928-----	6,798	1,980	16,183	128,327	991,207	339,000	108,095
Total, 1904-1928----	800,942	18,973	755,414	8,558,968	42,420,414	222,899,102	21,835,712

TAOS COUNTY

Red River district.—At the Silver King group of the Buffalo-New Mexico Mines Co., on Placer Creek, the 25-ton concentration mill was operated experimentally but no disposition of the concentrates was made in 1928. Retimbering was done at the mine. The openings on this property consist of a 322-foot vertical shaft, 4,200 feet of adits, and 1,200 feet of drifts. The mill equipment consists of 1 Universal crusher, 1 Ellis Chile-type mill, 1 Wilfley table, and 1 Card table. At the Independence group development work was done on 4 claims. Development to the end of 1928 includes a 110-foot vertical shaft and 750 feet of drifts. At the Silver Tip group, on Pioneer Creek, 412 feet of new timbering was placed in the New York adit, 50 feet was added to its length, and an adit known as the Ajax Tunnel was started and driven 50 feet. Assessment work was done on several other properties in the Red River district.

Sulphur Creek district.—Molybdenum ore from the Phyllis group was milled at the 20-ton flotation mill at the junction of Sulphur Creek and Red River, above Questa.

TORRANCE COUNTY

The increased price of copper in 1928 resulted in the reopening of copper prospects in the "Red Beds," near Scholle, and in the shipment of 1,943 tons of 10 per cent copper ore, carrying also 1 ounce of silver to the ton and a trace of gold.

VALENCIA COUNTY

Assessment work was done at the Valencia copper prospects, at Diener, 15 miles west of Grant.

GOLD, SILVER, COPPER, AND LEAD IN TEXAS¹

(MINE REPORT)

By CHAS. W. HENDERSON

SUMMARY

The mine production of gold, silver, copper, and lead in Texas from 1919 to 1928 has been as follows:

Mine production of gold, silver, copper, and lead in Texas, 1919-1928, in terms of recovered metals¹

Year	Ore (short tons)	Gold	Silver		Copper		Lead		Total value
			Fine ounces	Value	Pounds	Value	Pounds	Value	
1919.....	54,510	\$25	538,642	\$603,279	979	\$182	13,131	\$696	\$604,182
1920.....	56,269	-----	511,401	557,427	14,435	2,656	-----	-----	560,083
1921.....	58,527	-----	516,766	516,766	-----	-----	-----	-----	516,766
1922.....	69,420	-----	644,980	644,980	4,290	579	8,016	441	646,000
1923.....	78,610	802	811,824	665,696	4,257	625	26,605	1,862	668,985
1924.....	84,744	-----	720,739	482,895	-----	-----	-----	-----	482,895
1925.....	72,737	-----	552,000	383,088	-----	-----	16,000	1,392	384,480
1926.....	34,042	2,270	447,237	279,076	12,620	1,767	83,890	6,711	289,824
1927.....	50,759	8,192	1,034,866	586,769	21,458	2,811	487,984	30,743	628,515
1928.....	76,915	10,115	1,340,622	784,264	447,792	64,482	695,570	40,343	899,204

¹ Total production from 1885 to 1927 and prices used in calculating values are shown in the chapter of this series in Mineral Resources, 1927, Pt. I, pp. 477 and 478.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

¹ Work on manuscript completed January, 1930.

REVIEW BY COUNTIES

BREWSTER COUNTY

In 1928 the Altuda Mining Co., of Alpine, shipped one car of lead-silver ore from the Bird mine to the El Paso smelter.

CULBERSON COUNTY

Lessees on the dumps of the Hazel mine, 14 miles north of Van Horn, continued in 1928 to ship to the El Paso smelter, increasing the shipments from this source from 2,500 tons in 1927 to approximately 10,000 tons in 1928. This dump material averaged 9 ounces silver to the ton and 0.42 per cent copper. In January, 1928, the World Exploration Co. started operations at the mine, reconditioned the old buildings and constructed new ones, and erected a 65-foot headframe and 150-ton ore bin. The old shaft was enlarged to 4½ by 10½ feet in the clear and was timbered with 8 by 8 inch timbers and lagged, making a 3-compartment shaft to the 340-foot level of the old single-compartment 740-foot shaft. Underground work was started in August, 1928, and drifts and crosscuts were run. Shipments from underground workings in 1928 were 4,810 tons of highly siliceous (66 per cent SiO_2) oxidized ore, carrying 7.63 ounces silver to the ton and 1.53 per cent copper. This property was first opened in 1883 and was operated intermittently until 1917; it was then idle until lessees began shipping from the dumps in 1927.

HUDSPETH COUNTY

Two cars of silver ore, carrying also a small content of copper and lead, were shipped from the Little Lightning mine, 7 miles north of Allamoore, and over 3,000 tons of copper-silver ore was shipped from the Sancho Panza mine, in the NW. ¼ of the NW. ¼ of section 13, block 67, township 7, also 7 miles north of Allamoore. Two 1-ton lots of lead-silver ore were shipped from prospects near Sierra Blanca.

PRESIDIO COUNTY

The American Metal Co., which opened ore by new development work at the old Presidio mine between September, 1926, and February 22, 1927, continued to operate throughout 1928, making a new yearly record of recovered metals for the mine—1,212,340 ounces of silver, 681,000 pounds of lead, and 489 ounces of gold. This mine was first opened in 1884 and production began in 1885; it has had an almost continuous record of production since that year. The total production of Texas, beginning with 1885, has been 21,362,768 ounces of silver, most of which has come from the Presidio mine. The total output from the mine has been approximately 1,200,000 tons. The mine is at Shafter, on Rio Grande River, 45 miles southwest of Marfa, at present the nearest railroad station.

The ore is found as a replacement of limestone beds and is oxidized, the principal mineral being silver chloride, with which are argentite, galena, and probably cerussite, in a quartz gangue. The mill, cyanidation and gravity concentration, has a 24-hour rating of 175 to 200 tons; it treated an average of 160 tons daily for 365 days in 1928. In 1928 the equipment consisted of 2 Sturtevant 10 by 15 inch crushers, 1 Blake 9 by 15 inch crusher, 15 Union Iron Works 1,200-pound

stamps, 2 Colorado Iron Works $4\frac{1}{2}$ by 18 foot tube mills, 2 Dorr 24-inch classifiers, 11 Wilfley No. 6 tables, 2 Oliver filters, 6 Pachuca agitation tanks, 2 Dorr tray thickening tanks, 2 Dorr standard thickening tanks, and the Crowe-Merrill vacuum precipitation system. At the close of 1928 a new 8A Telsmith primary crusher and a 3-foot Symons cone crusher were installed; they were put in operation in January, 1929. Because of the lime alkalinity the cyanide also dissolved much of the lead oxidized minerals, which with the silver were precipitated by the zinc dust, making a very high-grade precipitate of both lead and silver. These precipitates were shipped direct to the Selby refinery in California. The lead concentrates, which are made by table concentration of the oxidized ore, are high in lead content and relatively high in silver content, although the recovery factor naturally is not high.

The mine is opened by two vertical shafts, one 400 and the other 700 feet deep, and the old and new underground workings total over 25 miles of drifts and crosscuts. At present all work is done through the 700-foot shaft.



GOLD, SILVER, COPPER, LEAD, AND ZINC IN MONTANA ¹

(MINE REPORT)

By C. N. GERRY ²

SUMMARY

The value of the mine production of gold, silver, copper, lead, and zinc in Montana in 1928 was \$55,365,249, 12 per cent more than that in 1927, largely because of the great increase in the output of copper. There were also increases in the output of gold and zinc, but decreases in silver and lead.

An exact summary of the value of the metal output of Montana by years has never been compiled, but an estimate of \$1,099,019,699 was given by the Director of the Mint ³ for the gold, silver, copper, and lead produced from 1862 to 1903. Adding to this total the value of these metals and that of zinc from 1904 to 1928 gives a total of \$2,670,099,769 for the State from 1862 to the end of 1928.

The total value of the mine production of gold, silver, copper, lead, and zinc in Montana for the years 1904 to 1928, as recorded in Mineral Resources of the United States, has been \$1,571,080,070. Details of production are as follows: Ore, old tailings, etc., 126,753,224 short tons; gold, \$74,777,885; silver, 312,393,608 fine ounces; copper, 6,306,400,373 pounds; lead, 490,113,113 pounds; and zinc, 2,488,149,534 pounds.

Silver Bow County, which includes the Butte or Summit Valley district, continued to produce most of the silver, copper, lead, and zinc and produced nearly half the gold in 1928.

Published reports show that the Anaconda Copper Mining Co., Butte & Superior Mining Co., and Galt Mining Co. paid dividends in 1928 amounting to \$15,008,783, but part of the Anaconda dividend was paid from receipts from operations in other States. No complete record of the dividends paid by mining companies in Montana has ever been kept, but adding the dividends of the last four years to an estimate made by one of the mining journals ⁴ gives a total of \$379,123,387 to the end of 1928. The Anaconda, Amalgamated, North Butte, Butte & Superior, and Parrot companies have paid the larger part of this total.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average

¹ Work on manuscript completed February, 1930.

² The valuable assistance of Jeannette Froiseth and Paul Luff, of the Bureau of Mines, is acknowledged.

³ Director of the Mint, Ann. Rept. for 1904, p. 93.

⁴ Mining Truth, May 16, 1925, p. 93.

price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919-----	\$1.12	\$0.186	\$0.053	\$0.073	1924-----	\$0.670	\$0.131	\$0.080	\$0.065
1920-----	1.09	.184	.080	.081	1925-----	.694	.142	.087	.076
1921-----	1.00	.129	.045	.050	1926-----	.624	.140	.080	.075
1922-----	1.00	.135	.055	.057	1927-----	.567	.131	.063	.064
1923-----	.82	.147	.070	.068	1928-----	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in Montana, 1919-1928

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919-----	395	62	4,183,594	107,856.32	\$2,229,588	12,541,181	\$14,046,123
1920-----	392	65	5,241,615	89,550.11	1,851,165	12,579,178	13,711,304
1921-----	348	97	1,324,801	71,631.91	1,480,763	6,558,713	6,558,713
1922-----	315	78	4,385,878	80,145.62	1,656,757	12,468,151	12,468,151
1923-----	304	78	5,743,535	85,079.43	1,758,748	13,380,862	10,972,307
1924-----	302	86	4,652,482	97,854.16	2,022,825	13,289,303	8,903,833
1925-----	331	93	4,405,008	82,122.85	1,697,630	13,158,191	9,131,784
1926-----	335	58	4,470,055	60,504.11	1,250,731	12,769,092	7,967,913
1927-----	247	60	4,222,607	53,541.25	1,106,796	11,200,077	6,350,444
1928-----	236	43	4,344,279	58,196.09	1,203,020	10,853,276	6,349,166

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919-----	169,981,288	\$31,616,520	34,437,764	\$1,825,201	168,763,823	\$12,319,759	\$62,037,191
1920-----	177,059,260	32,578,904	31,253,916	2,500,313	184,337,786	14,931,361	65,573,047
1921-----	48,098,730	6,204,736	20,366,917	916,511	23,275,966	1,163,798	16,324,521
1922-----	165,754,442	22,376,850	29,767,479	1,637,211	119,069,818	6,786,980	44,925,949
1923-----	224,125,264	32,946,414	35,945,623	2,516,194	141,460,392	9,619,307	57,812,970
1924-----	249,152,062	32,638,920	39,476,008	3,158,081	128,475,218	8,350,889	55,074,548
1925-----	268,910,847	38,185,340	37,530,644	3,265,166	115,316,922	8,764,086	61,044,006
1926-----	255,372,862	35,752,201	42,806,193	3,384,495	147,401,507	11,055,113	59,410,453
1927-----	223,492,639	29,277,536	35,898,315	2,261,594	160,461,803	10,269,555	49,265,925
1928-----	248,262,027	35,749,732	33,759,644	1,958,059	165,660,189	10,105,272	55,365,249

Gold and silver produced at placer mines in Montana, 1919-1928

Year	Gold		Silver		Year	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value		Fine ounces	Value	Fine ounces	Value
1919-----	14,097.92	\$291,430	2,309	\$2,586	1924-----	1,323.59	\$27,361	187	\$125
1920-----	13,977.76	288,946	2,210	2,409	1925-----	1,905.25	39,385	405	281
1921-----	10,988.91	227,161	1,591	1,591	1926-----	1,104.30	22,828	162	101
1922-----	3,472.65	71,786	652	652	1927-----	1,079.97	22,325	197	112
1923-----	1,972.68	40,779	360	295	1928-----	865.14	17,884	149	87

GOLD

The mine production of gold in Montana in 1928 was nearly 9 per cent more than that of 1927, due chiefly to the operation of the Spring Hill mine near Helena by the Montana-Idaho Mines Corporation. This property, a large producer of gold in the past, was again brought to a producing stage in 1928, when it became the third largest producer of gold in Montana. The Anaconda Copper Mining Co. and the Liberty Montana Mines Co. increased their output of gold considerably. The output of gold in Montana has decreased from \$5,004,195 in 1915 to \$1,203,020 in 1928. Silver Bow County reported nearly half the total for the State in 1928; its output increased nearly 10 per cent as compared with that in 1927. Lewis and Clark County was second in output in 1928 and was followed closely by Madison County. Amalgamation and cyanidation mills produced 19 per cent of the total gold, yielding an average of \$3.58 in gold and 14 cents in silver to the ton of ore and old tailings treated. Concentrates of all kinds yielded 68 per cent of the total gold, and crude ore shipped to smelters yielded 10 per cent. Dry and siliceous ore, old tailings, etc., yielded 32 per cent of the gold; copper ore, old tailings, etc., 58 per cent; lead ore and copper-lead ore, 1 per cent; zinc ore and slag and lead-zinc ore and old tailings, 8 per cent; and placers, 1 per cent. There was a decided increase (more than 6,300 ounces) in gold from copper ore and a slight increase from lead-zinc ore, but a decrease from lead ore and zinc ore. The output of gold from siliceous ore was nearly the same as that in 1927.

Four properties produced 73 per cent of the total gold from Montana in 1928. The Anaconda property at Butte ranked first, followed by the property of the Liberty Montana Mines Co. near Jefferson Island, Madison County, the Spring Hill mine near Helena, and the New Gould property near Wilborn, both in Lewis and Clark County. Other large producers of gold were the Drumlummon mine near Marysville, Lewis and Clark County; the Butte & Superior and Emma properties at Butte, Silver Bow County; and the Granite Bimetallic tailings dump near Philipsburg, Granite County.

SILVER

The output of silver from mines in Montana in 1928 was 3 per cent less than in 1927 and was less than the yearly average of 11,879,800 ounces for the decade 1919 to 1928. The decrease in 1928 was chiefly because of the large decreases in lead ore and old tailings and lead-zinc ore mined in Jefferson County and copper-lead ore in Cascade County. More than 52 per cent of the total silver was obtained from copper ore, old tailings, etc., nearly 38 per cent from lead-zinc ore and old tailings, 5 per cent from lead ore and copper-lead ore, and 3 per cent from siliceous ore. Silver Bow County, chiefly the Butte district, produced 88 per cent of the total. Concentrates yielded 95 per cent of the silver, first-class smelting ore 4.5 per cent, old tailings, slag, etc., smelted less than 1 per cent, and bullion from ore treated at cyanidation and amalgamation mills less than one-half of 1 per cent. The large increase in silver from lead-zinc ore offset the large decreases from zinc ore and copper ore; there were also decreases in silver from lead ore and copper-lead ore.

Eight properties produced 87 per cent of the total silver from Montana in 1928; each of these yielded more than 300,000 ounces and two of them—the copper mines of the Anaconda Copper Mining Co. and the Butte & Superior mine—more than 1,500,000 ounces each. The Anaconda Copper Mining Co. produced nearly half of the State's output of silver in 1928. The other six large producers were the Elm Orlu, Emma, East Butte, Ardsley Butte, Poser, and Silver Dyke properties.

COPPER

The mine production of copper in Montana in 1928 was 11 per cent more in quantity than in 1927. As the price of copper increased in 1928 and the demand for copper was greater, an effort was made to work the mines and milling and smelting plants at maximum capacity. Except for 1,195,065 pounds, the total output of copper came from Silver Bow County, which includes the Butte district. Copper ore, old tailings, etc., yielded more than 98 per cent of the copper. Concentrates yielded nearly 94 per cent of the copper and crude ore of all kinds shipped to smelters 3 per cent; the remainder (3 per cent) of the copper was saved from old tailings smelted, pond slimes, slag, and precipitates. The sulphide copper ore of smelting grade yielded 7,542,016 pounds of copper, an average of 4.67 per cent, and the oxidized copper ore 315,960 pounds, an average of 7.76 per cent. Slag resmelted, old tailings and pond slimes smelted, and copper precipitates from mine waters yielded 7,811,970 pounds of copper.

Three properties in Montana each produced more than 2,000,000 pounds of copper in 1928. The mines of the Anaconda Copper Mining Co. yielded more than 93 per cent of the State's output; the other two properties were the East Butte and Anselmo. Other large producers of copper were the Butte & Superior, Elm Orlu, and Silver Dyke mines. The Anaconda Copper Mining Co. and the East Butte Copper Mining Co. were the only large producers of copper at Butte to increase their output.

LEAD

The mine production of lead in Montana in 1928 was 6 per cent less in quantity than that in 1927. The large decreases in lead from lead ore and zinc ore offset the large increase from lead-zinc ore. Seventy-three per cent of the output in 1928 was recovered from ore mined in Silver Bow County, and most of the remainder came from Cascade, Broadwater, Lewis and Clark, Madison, and Jefferson Counties. Lead-zinc ore and old tailings yielded 80 per cent of the lead, zinc ore and slag 3 per cent, lead ore 9 per cent, and copper-lead ore 7 per cent. Concentrates yielded more than 88 per cent of the total output of lead, crude ore of all kinds shipped to smelters nearly 9 per cent, and old slag nearly 3 per cent. The greater part of the lead from Montana mines, saved at East Helena, arrives at the smelter in residues from the zinc plants at Anaconda and Great Falls or in lead concentrate from the mill at Anaconda.

Five properties—the Emma, Butte & Superior, Poser, Elm Orlu, and Silver Dyke, each yielding more than 2,000,000 pounds—produced most of the lead. Other large producers were the Joe Dandy property of the Butte Copper Consolidated Mines, East Helena slag dump, Otisco, and Commonwealth properties.

ZINC

The mine production of zinc in Montana in 1928 was 3 per cent greater in quantity than that in 1927 and was the largest output since 1920. The zinc output from the Butte & Superior mine was 15 per cent less than that in 1927, but the output from the Elm Orlu and Emma mines was considerably increased. The chief cause for the increase in zinc was the large quantity recovered from the East Helena slag by the Anaconda Copper Mining Co. The mines at Butte, Silver Bow County, produced 89 per cent of the total zinc from Montana in 1928, and most of the remainder came from the new slag plant at East Helena. At Great Falls the electrolytic zinc plant of the Anaconda Copper Mining Co. was operated continuously. The daily capacity of this plant is 350 tons of cathode zinc. The new plant at Anaconda was completed early in 1928 and was operated regularly at a rate of 175 tons of cathode zinc per day. Most of the lead-zinc ore was treated at the Timber Butte custom mill at Butte and the custom plant at Anaconda. The Butte & Superior Mining Co., which shipped its entire lead-zinc product to Anaconda for milling, produced approximately 34 per cent of the zinc of the State and the Elm Orlu and Emma mines about 40 per cent. Lead-zinc ore yielded 90 per cent of the zinc and zinc ore 10 per cent.

Four properties at Butte—the Butte & Superior, Elm Orlu, Emma, and Poser—produced nearly all the zinc. These four properties, each producing more than 15,500,000 pounds of zinc, yielded nearly 84 per cent of the State's total output. Zinc recovered from the East Helena fuming plant represented nearly 8 per cent of the State's output. Other large producers of zinc were the Otisco, Anaconda (zinc), and Silver Prince properties.

The following tables show the relative importance of Silver Bow County or the Butte district. Lewis and Clark County was the only other county in Montana that produced metals valued at more than \$1,000,000 in 1928.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1928, by counties

County	Gold					Silver (lode and placer)	
	Lode		Placer		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Beaverhead.....	80.74	\$1,669	10.45	\$216	\$1,885	45,889	\$26,845
Broadwater.....	794.66	16,427	178.79	3,696	20,123	44,818	26,219
Cascade.....	355.99	7,359	-----	-----	7,359	512,440	299,777
Deer Lodge.....	394.59	8,157	7.16	148	8,305	3,233	1,891
Fergus.....	95.44	1,973	-----	-----	1,973	1,701	995
Flathead.....	8.03	166	-----	-----	166	59,631	34,884
Granite.....	1,122.73	23,209	42.43	877	24,086	381,782	223,343
Jefferson.....	1,021.34	21,113	8.85	183	21,296	73,851	43,203
Judith Basin.....	29.37	607	1.35	28	635	31,809	18,608
Lewis and Clark.....	12,240.38	253,031	17.51	362	253,393	71,592	41,881
Lincoln.....	731.38	15,119	-----	-----	15,119	3,504	2,050
Madison.....	11,165.34	230,808	150.25	3,106	233,914	54,663	31,978
Meagher.....	-----	-----	-----	-----	-----	74	43
Mineral.....	.96	20	102.85	2,126	2,146	5,550	3,247
Missoula.....	.44	9	2.32	48	57	682	399
Park.....	4.26	88	-----	-----	88	-----	-----
Phillips.....	220.11	4,550	3.29	68	4,618	740	433
Powell.....	249.90	5,166	284.11	5,873	11,039	1,722	1,007
Ravalli.....	-----	-----	1.79	37	37	-----	-----
Sanders.....	-----	-----	-----	-----	-----	976	571
Silver Bow.....	28,815.29	595,665	53.99	1,116	596,781	9,558,619	5,591,792
Total, 1927.....	57,330.95	1,185,136	865.14	17,884	1,203,020	10,853,276	6,349,166
	52,461.28	1,084,471	1,079.97	22,325	1,106,796	11,200,077	6,350,444

Mine production of gold, silver, copper, lead, and zinc in Montana in 1928, by counties—Continued

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Beaverhead.....	54, 813	\$7, 893	599, 802	\$34, 789	108, 772	\$6, 635	\$78, 047
Broadwater.....	12, 021	1, 731	1, 552, 697	90, 056	9, 168	559	138, 688
Cascade.....	768, 971	110, 732	2, 863, 135	166, 062	766, 826	46, 776	630, 706
Deer Lodge.....	363	52					10, 248
Fergus.....							2, 968
Flathead.....							35, 050
Granite.....	64, 852	9, 339	683, 423	39, 639	2, 548, 695	155, 470	451, 877
Jefferson.....	67, 414	9, 708	795, 178	46, 120	1, 025, 482	62, 555	182, 882
Judith Basin.....	8, 329	1, 199	540, 000	31, 320	347, 278	21, 184	72, 946
Lewis and Clark.....	6, 081	876	990, 325	57, 439	12, 752, 256	777, 888	1, 131, 477
Lincoln.....	290	42	99, 815	5, 789	36, 843	2, 248	25, 248
Madison.....	210, 036	30, 245	880, 375	51, 062	11, 175	682	347, 881
Meagher.....	271	39	1, 334	77	20, 399	1, 244	1, 403
Mineral.....	532	77	72, 884	4, 227	135, 127	8, 243	17, 940
Missoula.....	97	14	1, 765	102	2, 135	130	702
Park.....							88
Phillips.....			122	7			5, 058
Powell.....	41	6	4, 000	232			12, 284
Ravalli.....							37
Sanders.....	954	137	14, 504	841			1, 549
Silver Bow.....	247, 066, 962	35, 577, 642	24, 660, 285	1, 430, 297	147, 896, 033	9, 021, 658	52, 218, 170
Total, 1927.....	248, 262, 027	35, 749, 732	33, 759, 644	1, 958, 059	165, 660, 189	10, 105, 272	55, 365, 249
	223, 492, 639	29, 277, 536	35, 898, 315	2, 261, 594	160, 461, 803	10, 269, 555	49, 265, 925

Ore, old tailings, etc., sold or treated, lode mines producing, and average value of ore, etc., in gold and silver in Montana, 1927 and 1928, by counties

County	Ore, old tailings, etc. (short tons)		Lode mines produc- ing		Average value per ton in gold and silver	
	1927	1928	1927	1928	1927	1928
Beaverhead.....	9, 249	1, 432	12	9	\$2. 07	\$19. 91
Broadwater.....	12, 978	8, 090	18	16	5. 68	5. 27
Cascade.....	279, 544	199, 945	8	8	1. 45	1. 54
Deer Lodge.....	795	488	4	3	17. 59	20. 59
Fergus.....	60	65	3	3	53. 40	45. 66
Flathead.....		585		1		59. 91
Granite.....	57, 615	49, 843	18	17	3. 04	4. 95
Jefferson.....	40, 941	9, 162	36	36	5. 45	7. 02
Judith Basin.....	3, 559	5, 633	5	5	6. 27	3. 41
Lewis and Clark.....	34, 862	130, 558	25	24	7. 04	2. 26
Lincoln.....	5, 002	1, 460	3	7	. 84	11. 76
Madison.....	22, 240	38, 754	51	45	8. 98	6. 78
Meagher.....	1, 412	39	3	1	. 28	1. 10
Mineral.....	471	393	3	2	12. 50	8. 31
Missoula.....		15		1		27. 20
Park.....	40	1	1	1	57. 10	88. 00
Phillips.....	31	1, 549	2	4	81. 03	3. 22
Powell.....	517	182	11	10	34. 05	33. 76
Sanders.....	45	37	1	1	2. 38	15. 43
Silver Bow.....	3, 753, 246	3, 896, 048	43	42	1. 60	1. 59
	4, 222, 607	4, 344, 279	247	236	1. 76	1. 73

Production of placer mines in Montana in 1928, by counties

County	Mines		Gold	Silver (fine ounces)	Total value
	Drift	Hydrau- lic and sluicing			
Beaverhead.....		2	\$216	2	\$217
Broadwater.....		4	3,696	37	3,718
Deer Lodge.....		1	148	2	149
Granite.....		6	877	7	881
Jefferson.....		3	183	2	184
Judith Basin.....		1	28		28
Lewis and Clark.....	1	2	362	2	363
Madison.....	1	3	3,106	23	3,119
Mineral.....		7	2,126	3	2,128
Missoula.....		1	48		48
Phillips.....		1	68		68
Powell.....		8	5,873	47	5,901
Ravalli.....		1	37		37
Silver Bow.....		1	1,116	24	1,130
	2	41	17,884	149	17,971
Total, 1927.....	6	54	22,325	197	22,437

MINING INDUSTRY

The productive activity of the mining industry of Montana in 1928, with its allied milling and smelting industries, is conclusively shown by the aggregate value of the five metals produced, the dividend payments, and the increase in the output of gold, copper, and zinc. Compared with other States, Montana was second in the production of silver, third in copper, and fourth in zinc in 1928. The higher average metal prices of silver and copper in 1928, compared with those of 1927, were conducive to steady production at all the large mines of Butte, except the North Butte property. The average production from the Butte district was about 20,589,000 pounds of net copper a month, and the mills, smelters, electrolytic plants, and refineries at Butte, Anaconda, and Great Falls were operated regularly throughout the year.

No dredges were worked in Montana. It is interesting to note, however, that the gold production increased by reason of increased amounts from copper ore from Butte and from siliceous ore and copper ore from Lewis and Clark and Madison Counties. Factors that affected production, especially zinc production in 1928, were the regular operations of the new electrolytic zinc plant at Anaconda and the new fuming plant at East Helena treating current slag from the lead smelter. The Anaconda Copper Mining Co., which operates both these plants, spent more than \$2,700,000 in 1928 in construction and improvements in its mines and plants in Montana.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in Montana, 1919-1928, with content in terms of recovered metals

DRY AND SILICEOUS ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	221, 686	64, 289. 55	1, 707, 053	396, 501	140, 694	-----
1920.....	178, 352	45, 293. 42	2, 000, 162	358, 808	611, 004	-----
1921.....	164, 906	47, 377. 95	1, 546, 910	85, 468	956, 655	-----
1922.....	373, 311	53, 343. 24	2, 197, 802	217, 906	581, 205	-----
1923.....	342, 253	54, 743. 81	1, 280, 235	50, 271	42, 867	-----
1924.....	207, 487	63, 174. 26	947, 083	309, 015	627, 015	-----
1925.....	194, 691	38, 081. 43	591, 369	157, 745	368, 128	-----
1926.....	93, 571	23, 810. 07	345, 456	55, 266	72, 924	-----
1927.....	111, 976	18, 389. 30	427, 105	22, 865	93, 674	-----
1928.....	112, 331	18, 492. 10	340, 876	13, 723	44, 673	-----

COPPER ORE

1919.....	3, 081, 451	16, 612. 99	6, 341, 825	¹ 165, 321, 847	-----	-----
1920.....	4, 002, 491	18, 720. 88	6, 030, 507	¹ 172, 581, 159	1, 847	-----
1921.....	928, 461	4, 733. 30	1, 663, 472	¹ 46, 888, 812	1, 029	-----
1922.....	3, 250, 213	13, 367. 13	5, 446, 684	¹ 162, 800, 743	-----	-----
1923.....	4, 420, 601	19, 776. 67	7, 619, 864	¹ 220, 471, 500	1, 864	-----
1924.....	3, 437, 931	24, 926. 12	7, 845, 180	¹ 243, 927, 687	-----	-----
1925.....	3, 190, 841	32, 352. 64	8, 656, 401	¹ 265, 201, 209	-----	-----
1926.....	3, 179, 051	27, 289. 67	7, 762, 190	¹ 250, 247, 871	-----	-----
1927.....	2, 958, 445	27, 241. 47	6, 201, 827	¹ 218, 647, 748	1, 630	-----
1928.....	3, 174, 509	33, 546. 34	5, 705, 513	¹ 244, 708, 989	-----	-----

LEAD ORE

1919.....	33, 551	3, 797. 15	747, 960	192, 927	6, 753, 703	-----
1920.....	64, 563	3, 084. 34	800, 856	199, 951	9, 583, 916	-----
1921.....	113, 481	4, 151. 98	1, 352, 125	215, 114	7, 414, 293	11, 167
1922.....	96, 203	2, 783. 02	647, 754	33, 275	8, 133, 697	-----
1923.....	105, 450	2, 368. 15	437, 703	184, 842	8, 741, 531	69, 560
1924.....	78, 656	1, 486. 37	287, 041	222, 066	7, 829, 188	-----
1925.....	118, 062	2, 393. 79	532, 219	387, 701	9, 320, 422	-----
1926.....	132, 039	2, 391. 32	514, 628	363, 825	8, 467, 354	-----
1927.....	57, 182	1, 540. 90	314, 100	196, 402	4, 912, 945	-----
1928.....	10, 419	574. 72	178, 520	14, 989	3, 005, 336	-----

COPPER-LEAD ORE

1919.....	971	90. 08	58, 335	86, 416	480, 662	-----
1920.....	1, 787	113. 83	38, 685	62, 508	375, 072	-----
1921.....	334	10. 59	26, 244	24, 388	166, 526	-----
1922.....	21, 251	659. 18	122, 153	204, 497	518, 697	-----
1923.....	106, 325	271. 05	340, 559	598, 152	1, 445, 059	-----
1924.....	160, 883	332. 74	573, 038	1, 181, 998	2, 339, 877	-----
1925.....	195, 327	2, 113. 50	555, 365	1, 382, 541	2, 576, 816	-----
1926.....	224, 322	331. 43	668, 986	1, 650, 177	3, 910, 331	-----
1927.....	263, 868	314. 92	559, 918	1, 573, 206	2, 812, 096	-----
1928.....	192, 839	284. 61	402, 705	804, 791	2, 490, 272	-----

ZINC ORE, LEAD-ZINC ORE, AND COPPER-LEAD-ZINC ORE

1919.....	845, 935	8, 968. 63	3, 683, 699	3, 983, 597	27, 062, 705	168, 763, 823
1920.....	994, 422	8, 359. 88	3, 706, 758	3, 856, 834	20, 682, 077	184, 337, 786
1921.....	117, 619	4, 369. 18	1, 968, 371	884, 948	¹ 1, 828, 414	23, 264, 799
1922.....	644, 900	6, 520. 40	4, 053, 106	2, 438, 021	20, 533, 880	119, 069, 818
1923.....	768, 906	5, 947. 07	3, 702, 141	2, 820, 499	25, 714, 302	141, 390, 832
1924.....	767, 525	6, 611. 08	3, 636, 774	3, 511, 296	28, 679, 928	128, 475, 218
1925.....	706, 087	5, 276. 24	2, 822, 432	1, 781, 651	25, 265, 278	115, 316, 922
1926.....	841, 072	5, 577. 32	3, 477, 670	3, 055, 723	29, 855, 584	147, 401, 507
1927.....	831, 136	4, 974. 69	3, 696, 930	3, 052, 418	28, 077, 970	160, 461, 803
1928.....	854, 181	4, 433. 18	4, 225, 513	2, 719, 535	28, 219, 363	165, 660, 189

¹ Includes copper recovered from precipitates.

Ore, old tailings, etc., sold or treated in Montana in 1928, with content in terms of recovered metals

Source	Mines producing	Ore, old tailings, etc.		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore.....	81	1 71, 102	1. 64	16, 810. 30	28. 89	51, 241	0. 47
Dry gold and silver ore.....	4	207	. 01	146. 14	. 25	4, 441	. 04
Dry silver ore.....	30	2 41, 022	. 94	1, 535. 66	2. 64	285, 194	2. 63
Copper ore.....	28	3 3, 174, 509	73. 07	33, 546. 34	57. 64	5, 705, 513	52. 57
Lead ore.....	61	10, 419	. 24	574. 72	. 99	178, 520	1. 64
Zinc ore.....	3	4 89, 405	2. 06	130. 07	. 22	117, 015	1. 08
Copper-lead ore.....	3	192, 839	4. 44	284. 61	. 49	402, 705	3. 71
Lead-zinc ore.....	49	5 764, 776	17. 60	4, 303. 11	7. 39	4, 108, 498	37. 86
Total, lode mines.....	6 236	4, 344, 279	100. 00	57, 330. 95	98. 51	10, 853, 127	100. 00
Total, placers.....	43			865. 14	1. 49	149	
Total, 1927.....	279 307	4, 344, 279 4, 222, 607	100. 00	58, 196. 09 53, 541. 25	100. 00	10, 853, 276 11, 200, 077	100. 00

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore.....	1, 122		7, 219	0. 02		
Dry gold and silver ore.....	177					
Dry silver ore.....	12, 424	0. 01	37, 454	. 11		
Copper ore.....	7 244, 708, 989	98. 57				
Lead ore.....	14, 989	. 01	3, 005, 336	8. 90		
Zinc ore.....	231, 958	. 09	1, 106, 400	3. 28	16, 053, 092	9. 69
Copper-lead ore.....	804, 791	. 32	2, 490, 272	7. 38		
Lead-zinc ore.....	2, 487, 577	1. 00	27, 112, 963	80. 31	149, 607, 097	90. 31
Total, 1927.....	7 248, 262, 027 8 223, 492, 639	100. 00	33, 759, 644 35, 898, 315	100. 00	165, 660, 189 160, 461, 803	100. 00

¹ Includes 1,975 tons of old tailings cyanided, 2 tons of old slag amalgamated, and 7 tons of old cleanings sold to a smelter.

² Includes 36,307 tons of old tailings concentrated and 68 tons of old tailings sold to a smelter.

³ Includes 24,996 tons of old tailings, 4 tons of slag, and 1,838 tons of pond slimes sold to a smelter.

⁴ Includes 68,127 tons of slag sold to a smelter.

⁵ Includes 4,978 tons of old tailings concentrated.

⁶ A mine producing more than one class of ore is counted but once in arriving at total for all classes.

⁷ Includes 6,701,580 pounds of copper recovered from precipitates.

⁸ Includes 4,515,407 pounds of copper recovered from precipitates.

Value of metals from ore, old tailings, etc., sold or treated in Montana in 1928, by kinds of ore

Kind of ore	Ore, old tailings, etc. (short tons)	Gold	Silver	Copper	Lead	Zinc	Total
Dry gold ore.....	71, 102	\$347, 500	\$29, 976	\$162	\$419		\$378, 057
Dry gold and silver ore.....	207	3, 021	2, 598	26			5, 645
Dry silver ore.....	41, 022	31, 745	166, 839	1, 789	2, 172		202, 545
Copper ore.....	3, 174, 509	693, 464	3, 337, 725	135, 238, 094			39, 269, 283
Lead ore.....	10, 419	11, 881	104, 434	2, 158	174, 309		292, 782
Zinc ore.....	89, 405	2, 689	68, 454	33, 402	64, 171	\$979, 239	1, 147, 955
Copper-lead ore.....	192, 839	5, 883	235, 582	115, 890	144, 436		501, 791
Lead-zinc ore.....	764, 776	88, 953	2, 403, 471	358, 211	1, 572, 552	9, 126, 033	13, 549, 220
Total, 1927.....	4, 344, 279 4, 222, 607	1, 185, 136 1, 084, 471	6, 349, 079 6, 350, 332	135, 749, 732 229, 277, 536	1, 958, 059 2, 261, 594	10, 105, 272 10, 269, 555	55, 347, 278 49, 243, 488

¹ Includes value of 6,701,580 pounds of copper recovered from precipitates.

² Includes value of 4,515,407 pounds of copper recovered from precipitates.

GOLD ORE

Gold ore and old tailings, largely dry and siliceous, were reported from 81 mines in Montana in 1928, compared with 79 in 1927. This

material, the output of which increased 40 per cent, yielded on the average \$4.89 in gold and 0.72 ounce of silver to the ton and a little copper and lead and was valued at \$5.32 in recovered metals a ton. Lewis and Clark, Broadwater, Phillips, and Madison Counties, in the order named, produced most of the gold ore; the Spring Hill mine, near Helena, Lewis and Clark County, was the largest producer, with the New Gould property at Wilborn, also in Lewis and Clark County, following.

GOLD AND SILVER ORE

Gold and silver ore was reported from four mines in four counties in Montana in 1928. This ore yielded on the average \$14.59 in gold and 21.45 ounces of silver to the ton and a little copper. Most of the output was smelting ore from the Bullion property near Basin, Jefferson County.

SILVER ORE

A total of 30 mines produced the output of siliceous silver ore and old tailings in Montana in 1928, which yielded on the average 77 cents in gold and 6.95 ounces of silver to the ton, 0.015 per cent of copper, and 0.046 per cent of lead. The output of this class of material was less than in 1927, as a result of the large decrease in the treatment of old silver tailings from the Granite Bimetallic dump in Granite County. Large producers of silver ore or old tailings in 1928 included the Granite Bimetallic dump at Philipsburg and the Hoffman property near Maxville, both in Granite County; the Eveline mine at Butte, Silver Bow County; and the Flathead mine near Kila, Flathead County.

COPPER ORE

Copper ore, old tailings, etc., the output of which increased 7 per cent compared with 1927, were reported from 28 mines in Montana in 1928 and represented 73 per cent of the total output of ore, etc., of the State. The average yield of the ore, etc., was 22 cents in gold and 1.80 ounces of silver to the ton, and 3.75 per cent of copper or 74.97 pounds to the ton; the average value in recovered metals a ton was \$12.07, exclusive of the value of copper from mine-water precipitates. Nearly all the copper ore was mined at Butte—largely from the Anaconda, East Butte, Anselmo, Butte & Superior, and Elm Orlu properties—and most of it was milling ore. The Liberty Montana Mines Co., operating the Mammoth property near Jefferson Island, Madison County, became the third largest producer of copper ore in Montana in 1928.

LEAD ORE

The output of lead ore reported from 61 mines in Montana in 1928 decreased from 57,182 tons in 1927 to 10,419 tons in 1928. Most of the lead material in 1927 was slag and old tailings; no material of this character was shipped in 1928. The average yield in 1928 was \$1.14 in gold and 17.13 ounces of silver to the ton, 0.07 per cent of copper, and 14.42 per cent of lead; the average value in recovered metals a ton was \$28.10. The largest producers of lead ore were the Kleinschmidt property near Winston, Broadwater County; the Hartley mine at Neihart, Cascade County; the Joe Dandy mine near Radersburg, Broadwater County; and the Calvin property near Melrose, Madison County.

ZINC ORE

The zinc material consisted of sulphide zinc ore concentrated and of slag re-treated to volatilize the zinc. The average yield of the ore and slag was 3 cents in gold and 1.31 ounces of silver to the ton, 0.13 per cent of copper, 0.62 per cent of lead, and 8.98 per cent of zinc; the average value in recovered metals a ton was \$12.84. Most of the zinc material was slag from the East Helena lead plant, treated in a special furnace by the Anaconda Copper Mining Co.; a large quantity of zinc ore, however, was produced from the property of the Anaconda Copper Mining Co. at Butte.

COPPER-LEAD ORE

Copper-lead ore of milling grade was mined chiefly from the deposit at the Silver Dyke property at Neihart, which is rapidly being depleted.

LEAD-ZINC ORE

The output of lead-zinc ore and old tailings in Montana in 1928 was reported from 49 mines and represented nearly 18 per cent of the total output of ore, etc., of the State; the quantity increased 53 per cent over that in 1927. The average yield was 12 cents in gold and 5.37 ounces of silver to the ton, 0.16 per cent of copper, 1.77 per cent of lead, and 9.78 per cent of zinc. The average value in recovered metals a ton was \$17.72. Four mines at Butte—the Butte & Superior, Elm Orlu, Emma, and Poser—produced nearly 88 per cent of the lead-zinc ore and old tailings; all of it was milled at Butte or Anaconda. The next largest producers were the Otisco, Ardsley Butte, Silver Prince, and Block P. properties. Large shipments of old tailings for custom milling were made from the Comet dump near Basin, Jefferson County, and large shipments of lead-zinc ore were made from the Galt and Queen of the Hills properties near Neihart, Cascade County, and from the Silver Prince and Trout mines near Philipsburg, Granite County.

Ore, old tailings, etc., sold or treated in Montana in 1928, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Beaverhead.....	102	40.09	221		3,822	
Broadwater.....	3,055	614.81	200		115	
Cascade.....	1	5.05	68			
Deer Lodge.....	486	393.70	2,984	363		
Fergus.....	13	91.10	15			
Granite.....	103	108.82	82			
Jefferson.....	1,061	290.87	280	38		
Lewis and Clark.....	² 62,141	12,161.88	43,296	82	121	
Lincoln.....	1,137	676.29	634	111	2,665	
Madison.....	³ 1,320	1,981.24	2,527	424	374	
Park.....	1	4.24				
Phillips.....	⁴ 1,549	220.08	740		122	
Powell.....	137	198.68	80			
Silver Bow.....	6	23.45	114	104		
Total, 1927.....	71,102	16,810.30	51,241	1,122	7,219	
	50,764	16,467.40	56,756	3,157	19,539	

¹ Old refinery clean-up sold to a smelter.

² Includes 1,900 tons of old tailings cyanided.

³ Includes 2 tons of old slag amalgamated and 75 tons of old tailings cyanided.

⁴ Includes 4 tons of old cleanings sold to a smelter.

Ore, old tailings, etc., sold or treated in Montana in 1928, by counties, with content in terms of recovered metals—Continued

DRY GOLD AND SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Jefferson.....	132	55.61	1,595	-----	-----	-----
Lewis and Clark.....	19	33.59	959	177	-----	-----
Madison.....	19	12.40	507	-----	-----	-----
Powell.....	37	44.54	1,380	-----	-----	-----
	207	146.14	4,441	177	-----	-----
Total, 1927.....	170	138.94	5,574	81	6,074	-----

DRY SILVER ORE

Beaverhead.....	20	0.59	3,842	-----	-----	-----
Cascade.....	25	.30	317	-----	1,499	-----
Deer Lodge.....	2	.90	247	-----	-----	-----
Fergus.....	62	4.37	1,686	-----	-----	-----
Flathead.....	585	8.02	59,631	-----	-----	-----
Granite.....	⁸ 37,996	851.20	149,200	9,980	29,659	-----
Jefferson.....	⁶ 218	36.08	6,479	-----	5,878	-----
Lewis and Clark.....	5	.60	177	-----	418	-----
Madison.....	8	.19	957	-----	-----	-----
Silver Bow.....	2,101	633.41	62,658	2,444	-----	-----
	41,022	1,535.66	285,194	12,424	37,454	-----
Total, 1927.....	61,042	1,782.96	364,775	19,627	68,061	-----

COPPER ORE

Beaverhead.....	43	0.05	915	5,938	-----	-----
Broadwater.....	56	1.33	111	8,168	-----	-----
Granite.....	195	5.43	11,336	16,117	-----	-----
Jefferson.....	407	123.99	7,932	21,679	-----	-----
Lewis and Clark.....	14	2.58	339	4,583	-----	-----
Madison.....	35,285	8,955.98	16,429	202,165	-----	-----
Silver Bow.....	⁷ 3,138,509	24,456.98	5,668,451	⁸ 244,450,339	-----	-----
	3,174,509	33,546.34	5,705,513	⁸ 244,708,989	-----	-----
Total, 1927.....	2,958,445	27,241.47	6,201,827	⁹ 218,647,743	1,630	-----

LEAD ORE

Beaverhead.....	181	13.84	3,713	1,962	94,013	-----
Broadwater.....	4,953	175.00	44,207	3,728	1,543,867	-----
Cascade.....	2,332	12.70	67,850	363	180,794	-----
Jefferson.....	354	71.50	3,587	1,698	98,160	-----
Judith Basin.....	132	4.80	2,653	179	73,171	-----
Lewis and Clark.....	252	41.70	19,994	1,239	62,239	-----
Lincoln.....	198	54.63	2,540	74	73,979	-----
Madison.....	1,972	193.85	32,785	4,751	860,609	-----
Powell.....	8	6.70	215	41	4,000	-----
Sanders.....	37	-----	976	954	14,504	-----
	10,419	574.72	178,520	14,989	3,005,336	-----
Total, 1927.....	57,182	1,540.90	314,100	196,402	4,912,945	-----

LEAD-ZINC ORE

Beaverhead.....	459	2.49	2,453	4,223	111,782	108,772
Broadwater.....	26	3.54	263	125	8,715	9,168
Cascade.....	5,385	90.45	76,436	7,026	582,046	766,826
Granite.....	11,549	157.31	221,157	38,755	653,764	2,548,695
Jefferson.....	¹⁰ 6,990	443.25	53,976	43,999	691,140	1,025,482
Judith Basin.....	5,501	24.59	29,156	8,150	466,829	347,278
Lincoln.....	125	.44	330	105	23,171	36,843
Madison.....	140	8.28	1,242	2,177	18,101	11,175
Meagher.....	39	-----	74	271	1,334	20,399
Mineral.....	393	.94	5,547	532	72,884	135,127
Missoula.....	15	.44	682	97	1,765	2,135
Silver Bow.....	734,154	3,571.38	3,717,182	2,382,117	24,481,432	144,595,197
	764,776	4,303.11	4,108,498	2,487,577	27,112,963	149,607,097
Total, 1927.....	498,732	3,766.18	2,089,742	2,040,795	21,712,105	90,210,398

⁵ Includes 36,307 tons of old tailings concentrated.

⁶ Includes 68 tons of old tailings sold to a smelter.

⁷ Includes 24,996 tons of old tailings, 4 tons of slag, and 1,838 tons of pond slimes sold to a smelter.

⁸ Includes 6,701,580 pounds of copper recovered from mine-water precipitates.

⁹ Includes 4,515,407 pounds of copper recovered from mine-water precipitates.

¹⁰ Includes 4,978 tons of old tailings concentrated.

Zinc and lead-zinc concentrates (as marketed from Montana mines and mills) sold to smelters in 1928

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of concentrates	Recovered zinc
		<i>Short tons</i>	<i>Pounds</i>	<i>Per cent</i>	<i>Pounds</i>
Zinc concentrates.....	Beaverhead, Broadwater, Cascade, Granite, Jefferson, Judith Basin, Lincoln, Meagher, Mineral, Missoula, and Silver Bow.	150, 393	174, 970, 838	58. 17	152, 427, 380
Lead-zinc concentrates..	Cascade, Jefferson, Madison, and Mineral.	458	533, 947	58. 29	480, 553
Total, 1927.....		150, 851 160, 206	¹ 175, 504, 785 185, 474, 836	58. 17 57. 89	¹ 152, 907, 933 160, 461, 803

¹ Exclusive of zinc recovered from the treatment of slag at East Helena.

METALLURGIC INDUSTRY

The principal methods of working Montana ores are concentrating, direct smelting, and leaching. The value of metals recovered from first-class smelting ore and from ore and old tailings treated in gold and silver mills in 1928 was only 3.5 per cent of the value of the State output.

Thirty-four milling plants of various kinds were active in Montana in 1928, although many of them ran for short periods only. They include 10 plants using the amalgamation process, 2 using amalgamation and concentration, 5 using cyanidation, 6 using table concentration, 3 using flotation equipment after table concentration, and 8 using straight flotation. There were also 2 copper-precipitating plants at Butte that recover copper from mine waters, 2 electrolytic zinc-leaching plants, and 1 fuming plant.

Of the ore, etc., treated at gold and silver mills, 17,006 tons (17,004 tons of ore and 2 tons of slag) was treated by amalgamation, with an average recovery per ton of \$5.35 in gold and 0.17 ounce of silver, and 45,662 tons of ore and 1,975 tons of old tailings were treated by cyanidation, with an average recovery per ton of \$2.95 in gold and 0.26 ounce of silver. During the year 252 pounds of quicksilver was used—0.015 pound per ton of ore amalgamated and 0.0347 pound per ounce of gold and silver bullion recovered—and 73,728 pounds of cyanide was used in gold and silver mills—3.86 pounds per ounce of gold and silver bullion and 1.55 pounds per ton of ore and old tailings treated. The quantity of ore and old tailings treated by these processes in 1928 was nearly double that of 1927, chiefly because of the large quantity of ore treated by cyanidation from the Spring Hill mine near Helena, Lewis and Clark County. The quantity of gold recovered by cyanidation increased 19 per cent and that recovered by amalgamation nearly 11 per cent.

Concentrating mills in Montana handled 94 per cent of the total material mined or treated. The resulting concentrates, together with those from gold and silver mills, averaged \$73.43 in recovered metals a ton compared with \$50.57 in 1927, although the quantity of concentrates produced was 23 per cent less than in 1927. The decrease in quantity of copper concentrate was especially marked. The copper concentrate exceeded all others combined in total value of metals

recovered, but it was less valuable per ton than any except dry and siliceous concentrate. On account of unusual interest in the relative importance of flotation as a means of concentration the products of flotation and of gravity concentration are given separately. Several mills use both processes, and it is impossible to separate the products.

Crude ore directly smelted in 1928 averaged \$18.25 in recovered metals a ton. A decrease of 24 per cent was recorded in the total quantity of ore smelted, especially in copper ore. The chief product was copper ore, averaging \$15.39 in recovered metals a ton.

The miscellaneous material, other than ore and old tailings milled and crude ore smelted, consisted of 95,040 tons of slag, old tailings, and pond slimes shipped for smelting and mine-water precipitates. It yielded 446.58 ounces of gold, 56,261 ounces of silver, 7,811,970 pounds of copper, 927,669 pounds of lead, and 12,752,256 pounds of zinc, and came chiefly from Silver Bow County.

Mine production of metals from gold and silver mills in Montana in 1928, by counties

County	Ore, old tailings, etc., treated (dry weight)		Recovered in bullion			
			Amalgamation		Cyanidation	
	Ore	Old tailings, etc.	Gold	Silver	Gold	Silver
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Broadwater.....	10		37.14	18		
Granite.....	6		33.97	9		
Jefferson.....	202		80.88	34	9.25	5
Lewis and Clark.....	59,567	1,900	3,932.13	2,723	6,589.81	11,789
Lincoln.....	1,000		22.00	15		
Madison.....	208	177	109.95	11	18.06	185
Park.....	1		4.24			
Phillips.....	1,545				181.98	318
Powell.....	127		177.16	58		
Total, 1927.....	62,666	1,977	4,397.47	2,868	6,799.10	12,297
	33,936	1,063	3,968.14	2,488	5,705.79	27,884

County	Concentrates and recovered metal				
	Concentrates produced	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Broadwater.....	1	4.50	20		
Lewis and Clark.....	200	869.02	22,117		
Lincoln.....	12	295.14	488	77	1,029
Total, 1927.....	213	1,168.66	22,625	77	1,029
	292	1,056.39	19,301	580	1,381

¹ Includes 2 tons of old slag.

Mine production of metals from concentrating mills in Montana in 1928, by counties

County	Ore and old tailings treated (dry weight)		Concentrates and recovered metal					
	Ore	Old tailings	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Beaverhead.....	459	-----	202	2.49	2,453	4,223	111,782	108,772
Broadwater.....	5,878	-----	1,006	602.44	19,820	2,651	188,482	9,168
Cascade.....	199,867	-----	7,400	350.05	508,242	768,971	2,844,055	766,826
Granite.....	13,069	36,307	4,405	1,018.97	360,475	47,769	683,423	2,548,695
Jefferson.....	2,082	4,978	1,611	466.95	54,048	44,037	691,140	1,025,482
Judith Basin.....	5,501	-----	788	24.59	29,156	8,150	466,829	347,278
Lincoln.....	255	-----	87	38.84	1,496	179	40,914	36,843
Madison.....	36,336	-----	1,840	9,308.38	20,449	201,832	81,124	11,175
Meagher.....	39	-----	20	-----	74	271	1,334	20,399
Mineral.....	393	-----	193	.94	5,547	532	72,884	135,127
Missoula.....	15	-----	4	.44	682	97	1,765	2,135
Powell.....	10	-----	3	21.52	22	-----	-----	-----
Silver Bow.....	3,785,024	-----	682,024	26,660.75	9,270,779	231,453,689	24,660,285	147,896,033
Total, 1927.....	4,048,928 3,932,331	41,285 81,775	699,583 912,248	38,496.36 34,189.98	10,273,213 10,447,282	232,532,401 207,730,497	29,844,017 31,770,692	152,907,933 160,461,803

Montana ore and old tailings concentrated in 1928, by methods of concentration

Method of concentration	Ore and old tailings concentrated	Concentrates and metal content		
		Concentrates produced ¹	Gold	Silver
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Flotation.....	3,858,705	4 691,380	28,380.50	9,886,025
Tables and flotation.....	227,473	7,408	9,202.58	384,173
Tables.....	4,035	795	913.28	3,015
	4,090,213	699,583	38,496.36	10,273,213

Method of concentration	Concentrates and metal content—Continued					
	Copper		Lead		Zinc	
	Gross	Recovered	Gross	Recovered	Gross	Recovered
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Flotation.....	241,767,051	231,571,164	31,374,949	27,680,985	175,504,785	152,907,933
Tables and flotation.....	1,161,902	961,011	2,209,259	2,098,796	-----	-----
Tables.....	282	226	67,762	64,236	-----	-----
	242,929,235	232,532,401	33,651,970	29,844,017	175,504,785	152,907,933

¹ Figures do not include 213 tons from ore first treated by amalgamation or cyanidation containing 1,168.66 ounces of gold, 22,625 ounces of silver, 96 pounds of copper (77 pounds recovered), and 1,083 pounds of lead (1,029 pounds recovered).

² Concentrates made at Anaconda are all classified as flotation product in spite of the fact that one section of the copper mill was at times used to make a table concentrate suitable for the manufacture of sulphuric acid or for fluxing converter slag.

Gross metal content of Montana concentrates produced in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	2,325	2,903.96	162,662	11,410	32,551	-----
Copper.....	521,972	31,914.38	5,459,811	238,584,523	-----	-----
Lead.....	18,871	1,151.21	1,760,855	1,265,431	20,425,959	-----
Zinc.....	150,393	3,381.29	2,526,209	2,109,319	10,878,625	174,970,838
Copper-lead.....	5,777	247.50	367,769	951,977	2,209,259	-----
Lead-zinc.....	458	66.68	18,532	6,671	106,659	533,947
	699,796	39,665.02	10,295,838	242,929,331	33,653,053	175,504,785

Mine production of metals from Montana concentrates in 1928

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Beaverhead.....	202	2.49	2,453	4,223	111,782	108,772
Broadwater.....	1,007	606.94	19,840	2,651	188,482	9,168
Cascade.....	7,400	350.05	508,242	768,971	2,844,055	766,826
Granite.....	4,405	1,018.97	360,475	47,769	683,423	2,548,695
Jefferson.....	1,611	466.95	54,018	44,037	691,140	1,025,482
Judith Basin.....	788	24.59	29,156	8,150	466,829	347,278
Lewis and Clark.....	200	869.02	22,117	-----	-----	-----
Lincoln.....	99	333.98	1,984	256	41,943	36,843
Madison.....	1,840	9,308.38	20,449	201,832	81,124	11,175
Meagher.....	20	-----	74	271	1,334	20,399
Mineral.....	193	.94	5,547	532	72,884	135,127
Missoula.....	4	.44	682	97	1,765	2,135
Powell.....	3	21.52	22	-----	-----	-----
Silver Bow.....	682,024	26,660.75	9,270,779	231,453,689	24,600,285	147,896,033
	699,796	39,665.02	10,295,838	232,532,478	29,845,046	152,907,933
Total, 1927.....	912,540	35,246.37	10,466,583	207,731,077	31,772,073	160,461,603

BY KINDS OF CONCENTRATES

Dry and siliceous.....	2,325	2,903.96	162,662	9,129	30,886	-----
Copper.....	521,972	31,914.38	5,459,811	229,039,043	-----	-----
Lead.....	18,871	1,151.21	1,760,855	1,012,340	19,401,663	-----
Zinc.....	150,393	3,381.29	2,526,209	1,705,113	8,224,109	152,427,380
Copper-lead.....	5,777	247.50	367,769	761,582	2,098,796	-----
Lead-zinc.....	458	66.68	18,532	5,271	89,592	480,553

Gross metal content of Montana crude ore shipped to smelters in 1928

Class of ore	Quantity (dry weight)	Gross metal content			
		Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	6,181	4,259.63	161,318	4,884	14,353
Copper.....	82,808	1,317.32	197,997	8,192,045	-----
Lead.....	4,757	498.72	91,612	16,535	2,717,562
Copper-lead.....	637	37.11	34,936	66,326	412,080
	94,383	6,022.78	485,863	8,279,790	3,144,025

Mine production of metals from Montana crude ore shipped to smelters in 1928

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Beaverhead.....	973	78.28	43,434	50,590	488,020
Broadwater.....	2,202	150.60	21,923	9,370	1,364,215
Cascade.....	78	5.95	4,198	-----	19,080
Deer Lodge.....	488	394.60	3,231	363	-----
Fergus.....	62	4.37	1,686	-----	-----
Flathead.....	585	8.02	59,631	-----	-----
Granite.....	461	69.82	21,291	17,083	-----
Jefferson.....	1,832	461.48	18,498	23,377	104,038
Judith Basin.....	132	4.80	2,653	179	73,171
Lewis and Clark.....	964	849.39	28,136	6,081	62,778
Lincoln.....	205	375.38	1,505	34	57,872
Madison.....	2,133	1,728.95	33,995	8,204	799,251
Powell.....	45	51.24	1,595	41	4,000
Sanders.....	37	-----	976	954	14,504
Silver Bow.....	84,186	1,839.90	240,111	7,801,303	-----
Total, 1927.....	94,383	6,022.78	485,863	7,917,579	2,986,929
	124,441	7,271.17	608,722	10,031,603	2,755,822

BY KINDS OF ORE

Dry and siliceous.....	6,181	4,259.63	161,318	4,594	13,665
Copper.....	82,808	1,317.32	197,997	7,857,976	-----
Lead.....	4,757	408.72	91,612	11,800	2,581,788
Copper-lead.....	637	37.11	34,936	43,209	391,476

REVIEW BY COUNTIES AND DISTRICTS

BEAVERHEAD COUNTY

The value of the mine production of metals in Beaverhead County decreased from \$87,215 in 1927 to \$78,047 in 1928. Most of the returns came from copper-lead ore shipped from the Hecla mine and from lead-zinc ore from the Ferdinand mine. Shipments of old slag from the Hecla dump ceased in 1927; as a result the value of the mine production in Beaverhead County decreased in 1928.

Argenta district.—One placer and four lode mines in the Argenta district produced 720 tons of ore, \$1,326 in gold, 5,218 ounces of silver, 5,904 pounds of copper, 204,707 pounds of lead, and 105,656 pounds of zinc, valued in all at \$23,546; the ore yielded on the average \$32.47 in metals a ton and consisted of 442 tons of concentrating ore which was reduced to 196 tons of concentrates, and of 278 tons of first-class smelting ore. The Ferdinand property near Argenta was worked by lessees. More than 400 tons of lead-zinc ore was shipped to Butte for milling, and a small quantity of lead ore was shipped to Midvale, Utah, for smelting. Five cars of oxidized lead ore were shipped by a lessee from the Iron Mountain claim, a considerable increase over the production of 1927 but a small output when compared with the production made in 1926. The Brownell claim, 14 miles west of Dillon, was also worked by a lessee who shipped two cars of oxidized lead ore; lessees working the Midnight claim of the Monidah Trust Co. shipped a few cars of gold ore containing a little lead and silver. The ore from the district was shipped by way of Dillon on the Oregon Short Line Railroad; most of it was lead-zinc ore milled at the custom flotation plant at Butte, Mont., and first-class lead ore smelted at Midvale Utah. The placer gold was an accumulation of nuggets from pas

operations. The Great Western Development Co. continued to develop its Dexter property by advancing the 700-foot tunnel.

Beaverhead district.—A small lot of oxidized copper ore was shipped from the Owl claim near Donovan.

Blue Wing district.—The Kent Mining Co., operating the Kent mine, 20 miles west of Dillon, shipped a small quantity of lead-zinc ore to Butte for custom milling and a small lot of oxidized ore to East Helena for smelting. A lessee working the New Departure claim shipped a car of ore containing nearly 200 ounces of silver to the ton.

Brown's Lake district (Rock Creek).—A car of oxidized copper ore was shipped from the Ivanhoe property on Rock Creek, 1 mile west of Brown's Lake. The ore is mixed with heavy garnet seams in limestone.

Bryant district (Melrose).—The Hecla mine, formerly a large producer of lead ore, was operated in 1928 by lessees, who shipped about 600 tons of copper-lead ore containing considerable silver to Midvale, Utah, for smelting. The mine is opened by a main tunnel 3,100 feet long and by numerous inclines from the surface to the main tunnel, the longest being about 3,000 feet. The smelter and concentrator, operated when the camp was flourishing, have been dismantled, and even the old slag dump has been sold. No systematic development was undertaken during 1928, and in December the property was sold to George B. Conway of Helena.

Elkhorn district (Coolidge).—The Boston-Montana Mines Co. worked its Elkhorn property near Coolidge and did 30 feet of drifting, 96 feet of crosscutting, and 24 feet of raising, but no ore was produced. The property was a large producer of copper-lead-silver ore in 1925, when the 600-ton flotation plant was operated.

Vipond district.—In October the Quartz Hill Mining Co. was organized to work the Lone Pine and Argyle Silver claims, 12 miles from Divide. The company installed new machinery, constructed an engine house, and did 400 feet of development.

BROADWATER COUNTY

The value of the mine production of metals in Broadwater County decreased from \$168,222 in 1927 to \$138,688 in 1928, as a result of the large decrease in the quantity of iron-gold ore from the Keating mine. The decrease from this source was partly offset by increased shipments of lead-silver ore from the Joe Dandy property.

Backer district (Canton).—Four placers and two lode mines in the Backer district produced 7 tons of ore, \$4,441 in gold, 69 ounces of silver, and 115 pounds of lead, valued in all at \$4,489. The Slim Jim property produced a small quantity of rich gold ore, which was treated by amalgamation and concentration, and a little gold ore from the Shaubert group was shipped directly to a smelter for testing purposes. Most of the placer output came from the Eldorado Bar property in Confederate Gulch, which was operated by private individuals; in 1929 it will be worked by the Diamond City Mines Co., which has secured title. Small quantities of placer bullion were recovered from the Robison, Hoxsey, and York claims, also in Confederate Gulch.

Beaver district (Winston).—Three lode mines in the Beaver district produced 2,917 tons of ore, yielding \$2,397 in gold, 22,392 ounces

of silver, 3,500 pounds of copper, 225,784 pounds of lead, and 4,620 pounds of zinc, valued in all at \$29,377, or \$10.07 in metals a ton. The output consisted of 53 tons of first-class smelting ore and of 2,864 tons of milling ore which was reduced to 398 tons of concentrates. A marked decrease in the production resulted from the cessation of shipments from the East Pacific property of the Montana-Idaho Mines Corporation late in 1927. The property was worked in 1928, and development consisted of sinking the shaft from the seventh to the eighth level, of 190 feet of drifting, 60 feet of crosscutting, and 57 feet of raising. The Little Olga & Quartette (Kleinschmidt) property was also worked by the Montana-Idaho Mines Corporation. Nearly 3,000 tons of lead ore was treated in the 25-ton flotation plant, and a small quantity of first-class lead ore containing considerable silver was shipped directly to a smelter. The mill operated from May 9 to October 20, and in November work was started on a new 3,400-foot tunnel 500 feet below the present workings. A small lot of lead-zinc ore from the January claim, 8 miles south of Winston on Weasel Creek, was shipped to a custom flotation mill.

Cedar Plains district (Radersburg).—Eight lode mines in the Cedar Plains district produced 5,125 tons of ore, \$12,949 in gold, 21,865 ounces of silver, 8,168 pounds of copper, and 1,313,177 pounds of lead, valued in all at \$103,080, or \$20.11 in metals a ton. The output consisted of 2,120 tons of first-class smelting ore, of 3,000 tons of concentrating ore which was reduced to 599 tons of concentrate, and of 5 tons of ore treated by amalgamation. The Butte Copper Consolidated Mines shipped nearly 2,000 tons of oxidized lead ore of smelting grade from the Joe Dandy group near Radersburg, did considerable development in drifting and crosscutting, and sank the vertical shaft an additional 300 feet; moreover, four new ore bodies were opened on the 400-foot level. The mine ranked sixth as a producer of lead in Montana in 1928. A few thousand tons of iron ore from the Keating mine was concentrated and yielded 600 tons of gold-bearing concentrate, which was shipped to the lead smelter at East Helena. One car of lead ore of smelting grade was shipped from the Santa Anita mine and one from the Summit property, and one car of oxidized copper ore was produced from the Copper Queen claim. Lessees worked the Ohio Keating mine and shipped two cars of iron ore containing more than 1 ounce of gold to the ton. The Surprise claim near Radersburg produced a small quantity of gold bullion recovered by amalgamation.

Park (Hassel) district (Townsend).—Three lode mines in the Park district produced 41 tons of ore, yielding \$336 in gold, 492 ounces of silver, 353 pounds of copper, 13,621 pounds of lead, and 4,548 pounds of zinc, valued in all at \$1,742, or \$42.49 in metals a ton. The output consisted of a few tons of first-class lead ore from the Double Standard and John L. properties and of a small quantity of lead-zinc mill ore from the Iron Mask mine.

CASCADE COUNTY

The value of the mine production of metals in Cascade County was \$630,706, a decrease of \$328,842 from the output of 1927. This decrease was the largest in any county in the State and was chiefly because of the decrease in the output of copper, silver, and lead from

the Silver Dyke property near Neihart and to the cessation of shipments of slag from the old smelter site near Gibson, below Great Falls. There was also a decrease in the shipments of lead-zinc ore from the mines near Neihart.

The Anaconda Copper Mining Co. operated its roasting, leaching, refining, and manufacturing plants at Black Eagle and Anaconda. The electrolytic zinc plant at Black Eagle and the new one at Anaconda treated zinc ore and concentrate from Montana, Idaho, Utah, Washington, and Nevada and made slab zinc at the rate of 26,760,205 pounds a month. The output of these plants was not given separately; the plant at Anaconda has a capacity of 10,000,000 pounds of slab zinc a month and that at Great Falls 20,000,000 pounds a month. As the original zinc plant near Great Falls was not able to handle the increased quantity of zinc concentrate coming from the mills in Utah another electrolytic zinc plant of 150 tons daily capacity (metallic zinc) was completed at Anaconda in February, 1928. The results of operations at the Great Falls and Anaconda plants are given under Silver Bow County, with other notes on the company.

The process of roasting, leaching, purification, and electrolysis used in treating zinc concentrate in the plants at Great Falls and Anaconda to save slab zinc and cadmium and to recover gold, silver, copper, and lead in residues was reviewed in a recent article⁵ which gave the flow sheet of each plant.

Giant Springs district.—Several thousand tons of old slag containing chiefly silver and lead were shipped in 1927 from the Gibson dump near Great Falls to the lead plant at East Helena. All this material was disposed of, as there were no shipments in 1928.

Montana district (Neihart).—Eight lode mines in the Montana district produced 199,945 tons of ore, yielding \$7,359 in gold, 512,440 ounces of silver, 768,971 pounds of copper, 2,863,135 pounds of lead, and 766,826 pounds of zinc, valued in all at \$630,706, or \$3.15 in metals a ton, a decrease from \$912,920 in 1927. The output consisted of 78 tons of first-class smelting ore and of 199,867 tons of milling ore which was reduced to 7,400 tons of concentrates. Although most of the ore was milled locally, some was shipped to a custom flotation plant at Butte. As in 1927, the largest producer in the district was the Silver Dyke mine, 3½ miles northeast of Neihart; its output, however, was considerably less in 1928 than in 1927. The mill, a 1,000-ton plant equipped for gravity concentration and flotation, was operated about eight months and treated more than 190,000 tons of copper-lead ore. The mine was worked most of the year, and more than \$47,000 was spent in development. The property, which ranked fourth as a producer of silver in Montana in 1927, dropped to eighth place in 1928, although it maintained its position as fifth in the production of lead, and sixth in the production of copper. The deposit was practically exhausted, and the mine was closed in April, 1929. The Galt Mining Co. operated its property from January until August and more than doubled its output, which was chiefly lead-zinc ore shipped to Butte for milling. The ore is separated at Butte into a lead concentrate and a lead-zinc concentrate. Dividends paid in 1928 but not published amounted to \$9,354. The Queen of the

⁵ Wiggin, Albert E., and Caples, R. B., Electrolytic Zinc Practice at Great Falls and Anaconda: Eng. and Min. Jour., vol. 128, Aug. 24, 1929, p. 319.

Hills property was worked by lessees who shipped about 2,000 tons of lead-zinc ore for custom milling; work in 1928 consisted chiefly of stoping. The Neihart Mining & Milling Co. operated a 100-ton flotation mill at Neihart from January to October and treated a few thousand tons of silver-lead ore from the dump of the Hartley mine, owned by the Neihart Consolidated Silver Mining Co. Nearly 400 tons of lead concentrate, averaging about 170 ounces of silver to the ton, was shipped to East Helena for smelting, but operations ceased in October. The Florence mine, owned by the M. & I. Mining Co., produced a car of first-class silver-lead ore. A lessee shipped a car of lead-zinc ore from the dump of the Moulton mine of the Broadwater Consolidated Mines Co. Other claims belonging to the Broadwater Consolidated Mines Co., including the Broadwater, Lizzie, and Rochester, were not productive, but considerable development was done from May until December. A car of silver-lead ore from the dump of the Silver Belt mine was shipped to East Helena for smelting, and a small test lot of gold ore from a property near Neihart was shipped to Bradley, Idaho.

DEER LODGE COUNTY

The copper-smelting plant, the copper flotation mill, the lead-zinc flotation mill, and the new electrolytic zinc plant of the Anaconda Copper Mining Co. near Anaconda were active throughout 1928. Copper ore from Butte and custom material from mines throughout the State were either concentrated at the large mill equipped to treat copper ore by flotation or directly smelted in the large copper plant equipped with reverberatories and converters. The adoption of differential flotation has practically eliminated jigs and tables, changed the fine crushing department, and raised the grade of the copper concentrate. The blast furnaces were not used. Custom lead-zinc ore was also treated in a flotation plant at Anaconda; the lead concentrate was shipped to East Helena and the zinc product went to Black Eagle and Anaconda to be roasted and treated in the electrolytic zinc plants. The development of milling at Anaconda and the present practice in treating copper ore and zinc material were recently described by the superintendent⁶ of concentration at the plant.

The value of the mine production of metals in Deer Lodge County decreased from \$14,185 in 1927 to \$10,248 in 1928. Most of the output was iron-gold ore from the Holdfast mine near Southern Cross.

Dry Gulch district.—A little gold bullion was recovered by sluicing at the Dry Gulch claims, 17 miles north of Anaconda in Dry Gulch.

Georgetown district (Southern Cross).—The Holdfast and Golden Wedge mines were the only producers in the Georgetown district in 1928. These two properties together produced 486 tons of gold-bearing iron ore, which yielded \$8,138 in gold, 2,984 ounces of silver, and 363 pounds of copper, valued in all at \$9,936. Most of the output (421 tons) came from the Holdfast mine, 15 miles from Brown's Quarry, a loading station on the Butte, Anaconda & Pacific Railroad.

Oro Fino district.—The Cashier group, 9 miles southeast of Race-track, produced one small lot of rich silver ore of smelting grade.

⁶Morrow, Bayard S., Both Copper and Zinc Ores Treated by Selective Flotation: Eng. and Min. Jour vol. 128, Aug. 24, 1929, p. 295.

FERGUS COUNTY

The mines near Hilger, Giltedge, Brooks, and Kendall were large producers until 1920, but the output has been greatly reduced in recent years, decreasing from \$3,204 in 1927 to \$2,968 in 1928.

North Mocassin district.—A small lot of mill cleanings and precipitates containing considerable gold was shipped from the site of the Kendall and Barnes King mills, 8 miles north of Hilger.

Warm Springs district (Brooks).—The Silver Queen mine, worked by an opencut from which 3,000 cubic feet of waste was removed in 1928, produced two cars of siliceous silver ore. A small lot of similar ore was produced from the Florence mine. Development, consisting of 300 feet of tunneling, was done at the Tail Holt property, a producer of unusually rich gold ore in 1927. A deposit of copper ore is being developed at the Hamilton property, 8 miles from Hilger.

FLATHEAD COUNTY

Hog Heaven district.—The Flathead mine, about 27 miles southwest of Kalispell near Kila and owned by the Anaconda Copper Mining Co., was operated under lease and produced several hundred tons of unusually rich silver ore of smelting grade. Considerable interest was shown in this new development, as no ore has been shipped from this region of northwestern Montana in recent years.

GRANITE COUNTY

The output of all metals except gold in Granite County increased. The total value increased from \$221,119 in 1927 to \$451,877 in 1928. The increase was one of the largest in the State, and was due chiefly to the shipping of several thousand tons of lead-zinc ore of milling grade from the Silver Prince and Trout mines near Philipsburg. There was also a large production of silver from the Granite Bimetallic dump, but the output was less than that in 1927. In 1922 the mines of the county produced metals valued at more than \$800,000.

Alps district.—A small quantity of gold ore from the Rainy Day property was treated in an amalgamation mill and the bullion was sent to the assay office at Helena.

Dunkleberg district.—The Red Wing mine near Jens, formerly part of the Forest Rose group, yielded a little exceptionally rich gold material which was panned from siliceous ore and sent to Denver, Colo.

First Chance district (Garnet).—Four placers and two lode mines in the First Chance district produced 87 tons of ore, \$1,965 in gold, and 67 ounces of silver, valued together at \$2,004, a decrease from \$4,946 in 1927. The ore yielded on the average \$15.24 in metals a ton; the placer output was valued at \$678. Placer gold was recovered by sluicing operations at the Elfers, Potlatch, and other claims in Deep Gulch near Garnet. The Lead King mine was worked a short time under lease, and a little rich gold ore was produced; a small quantity of concentrate, containing nearly 6 ounces of gold to the ton, was cleaned up from former operations and shipped to Anaconda for smelting. The output was much less than that in 1927; this partly accounts for the decrease in the value of the district production in 1928. The mine was a large producer of gold in 1924. The old Grant & Hartford property of the Butte & Garnet Gold

Mining & Milling Co., which has been a producer intermittently for 30 years, was worked in 1928 by a lessee who shipped a few tons of first-class gold ore for smelting.

Flint Creek district (Philipsburg).—Eight lode mines in the Flint Creek district produced 11,767 tons of ore which, with 36,307 tons of old tailings, yielded \$14,822 in gold, 333,821 ounces of silver, 48,641 pounds of copper, 682,228 pounds of lead, and 2,545,918 pounds of zinc, valued in all at \$411,981, or \$8.57 in metals a ton. The ore, excluding the old tailings, yielded on the average \$28.68 in metals a ton. In 1927 seven lode mines produced 55,572 tons of ore and old tailings with a total value in metals of \$178,632. Besides the old tailings reconcentrated in 1928 the output consisted of 239 tons of first-class smelting ore and of 11,528 tons of milling ore. The output of the Silver Prince property, formerly the Scratchall, consisted of more than 7,000 tons of lead-zinc ore shipped to Butte for milling and of two cars of first-class silver ore shipped to Anaconda for smelting. The mine was the largest producer in the district and, together with the Trout property which ranked second, was responsible for the large increase in the output of the district. In 1928 the Silver Prince property ranked eighth as a producer of zinc in Montana and ninth as a producer of silver. The mine is opened by a vertical shaft 500 feet deep, and 3,000 feet of development was done in 1928. The ore contains sphalerite, galena, and tetrahedrite. The Trout mine was operated by the Trout Mining Co. The property was worked most of the year on a 2-shift basis and produced more than 4,000 tons of lead-zinc ore, which was shipped to Butte for custom milling. The company also treated several thousand tons of manganese ore and shipped concentrate chiefly to eastern markets for use in storage batteries. Development in 1928 consisted of several hundred feet of crosscutting and of sinking the vertical shaft an additional 100 feet. In 1928 the mine ranked ninth as a producer of zinc in Montana and was also a large producer of silver. The Jefferson Milling Co. continued to treat old tailings containing chiefly silver from the Granite Bimetallic dump. The 250-ton flotation plant was operated seven months, and 1,015 tons of silver concentrate containing 101 ounces of silver to the ton was shipped to the East Helena lead plant. The production in 1928, however, was less than that in 1927. Lessees operated the Granite Bimetallic mine and shipped three cars of first-class silver ore. A small lot of lead-zinc ore from the Algonquin mine and a car of similar ore from the Mullen property were shipped by lessees to Butte, where the material was separated into a lead concentrate and a zinc concentrate. Lessees also worked the Headlight and Derby mines and shipped one car of first-class silver ore from each mine. The Moorlight Mining Co. continued to treat manganese ore from several mines in the district and shipped about 5,000 tons of concentrate averaging 48.39 per cent of manganese to an eastern battery company. Dividends paid in 1928 amounted to \$18,000. Details regarding the character and treatment of the manganese ore are given in the general report on manganese.⁷

Henderson (Black Pine) district.—The Combination mine, formerly known as the Black Pine property and a large producer of silver and

⁷ Furness, J. W., Mineral Resources, 1927, Pt. I, p. 186.

copper in the early days, was worked in 1928, and several cars of oxidized copper ore were shipped to Anaconda for smelting. The ore is hauled 9 miles to Philipsburg, a station on the Northern Pacific Railroad. Development in 1928 is said to have opened a large body of ore on the 1,100-foot level, some of which assays 100 ounces of silver to the ton and 3 per cent of copper.

Maxville district.—The Maxville Gold & Silver Mining & Development Co. worked the Hoffman mine, 1 mile northwest of Maxville, and treated nearly 2,000 tons of siliceous silver ore in a 100-ton flotation plant. The resulting concentrate, containing about 95 ounces of silver and 0.75 ounce of gold to the ton, was shipped to Anaconda for smelting. More than \$10,000 was spent in developing and equipping the mine, and it is said that enough ore is opened on the 100, 200, and 300 foot levels to run the mill two years.

Rock Creek district.—A lessee worked the Basin placer in Basin Gulch and recovered a small quantity of gold bullion. Small lots of placer gold were also recovered from other claims northwest of Philipsburg. The total production of the district in 1928 was valued at \$203, a marked decrease from \$3,453 in 1927.

South Boulder district (Maxville).—The output of the South Boulder district consisted of a few tons of siliceous gold ore of smelting grade from the Royal Gold claim and one car of lead-zinc ore from a property near Maxville.

JEFFERSON COUNTY

The value of the mine production of metals in Jefferson County was \$182,882 in 1928, as compared with \$437,711 in 1927. The quantity of ore and the output of all metals, especially silver and lead, decreased considerably; this decrease was due partly to lessened shipments of lead-zinc ore from the Mount Washington mine. The Jefferson Milling Co., a large producer of silver and lead in 1927, was idle in 1928. Further decrease was prevented by the marketing of a large quantity of old tailings containing lead and zinc from the Comet dump near Corbin.

Amazon district.—A car of first-class silver-lead ore was shipped from the Wilber Silver property. A small lot of similar ore was mined and shipped from the Amazon claim near Amazon.

Bigfoot district.—The Big Four mine on State Creek produced three cars of lead-zinc ore which was shipped to a custom flotation plant, and a few tons of siliceous gold ore from the State mine was treated by amalgamation.

Boulder district.—The Baltimore property 4 miles northwest of Boulder was worked by a lessee who shipped a few hundred tons of lead-zinc mill ore, two cars of first-class copper ore, and three cars of first-class silver-lead ore. A little development was done in 1928, but most of the year was spent in stoping ore. A small quantity of placer gold was recovered from a claim on Boulder River.

Cataract district (Basin).—Eleven lode mines in the Cataract district produced 731 tons of ore and 4,978 tons of old tailings, which yielded \$10,426 in gold, 40,945 ounces of silver, 27,741 pounds of copper, 442,753 pounds of lead, and 732,759 pounds of zinc, valued in all at \$108,752, or \$19.05 in metals a ton. The ore, excluding the old tailings, yielded on the average \$28.20 in metals a ton. The increase of \$73,267 was chiefly the result of shipments of old lead-zinc

tailings from the Comet dump, which constituted the largest production in the district. The district output consisted of 254 tons of first-class ore, 176 tons of ore treated by amalgamation, and 301 tons of concentrating ore which, with 4,978 tons of old tailings, was reduced to 1,082 tons of concentrates. The output of the Crystal mine, 8 miles from Basin, consisted of nearly 300 tons of lead-zinc ore, which was shipped to the custom flotation mill at Butte. The production in 1928, however, was much less than that in 1927. About 250 feet of development was done in 1928 in drifting and raising. A sample of exceptionally rich gold ore from past operations at the Jib property was marketed, and nearly 200 tons of gold ore from the dumps of the Lizzie Bell and Gray Lead mines, 10 miles from Wickes, was treated by amalgamation. A lessee worked the Bullion property and shipped four cars of gold and silver ore of smelting grade. A little first-class gold ore was produced from the Mantle property. The Morning Glory mine near Basin was operated the entire year, and two cars of rich silver ore were shipped for smelting. Small lots of sulphide lead ore of smelting grade were produced from the Hattie Ferguson, Buckeye, and Comet mines; a little lead-zinc ore was also produced from the Comet mine and shipped to Butte for custom milling. The property of the Jib Consolidated Mining Co., the largest producer in the district from 1923 to 1926 but idle in 1927, was taken over in November, 1928, by the Basin Cataract Mining Co. and development work was resumed. In June operations were again started by the Basin-Montana Tunnel Co. at the Gray Eagle property. No production was reported, but the old tunnel was repaired, machinery was installed, and about 1,500 feet of development opened several bodies of silver-lead-zinc ore. The company owns 74 claims covering about 1,200 acres. A new tunnel 3 miles long is being driven and will tap numerous known veins. Late in the year the Creeden Mines Corporation started development at the Minneapolis property, also owned by the Basin-Montana Tunnel Co. The Doris Mining Co. was organized in March to operate property $1\frac{1}{4}$ miles up Basin Creek formerly worked by the Doris Leasing Co. Development in 1928 opened a body of ore assaying 5 ounces of silver to the ton, 13 per cent of lead, and 16 per cent of zinc.

Colorado district (Wickes).—Eight lode mines in the Colorado district produced 1,412 tons of ore, yielding \$4,276 in gold, 20,686 ounces of silver, 24,767 pounds of copper, 156,477 pounds of lead, and 175,248 pounds of zinc, valued in all at \$39,709, or \$28.12 in metals a ton. The output consisted of 374 tons of first-class smelting ore, 1 ton of ore which was treated by cyanidation, and 1,037 tons of milling ore which was reduced to 302 tons of concentrates. The large decrease of \$332,524 from the value of the output in 1927 was due chiefly to the curtailment of shipments of lead-zinc mill ore from the Mount Washington mine and the cessation of treating old silver-lead tailings from the Alta dump at Corbin. A lessee working the Mount Washington mine shipped about 1,000 tons of lead-zinc ore to Butte for milling and a few tons of sulphide lead ore to East Helena for smelting. The ore is hauled 2 miles to Wickes, a station on the Great Northern Railroad. No development was done in the mine in 1928. A car of lead-zinc milling ore was shipped for testing purposes by the Helena-Jefferson Mines Co. from its property 2 miles

south of Jefferson City, and two cars of similar material were shipped from the Alta Gregory dump. The Salvail mine, 2 miles west of Wickes, was worked by a lessee who shipped more than 300 tons of copper ore of smelting grade to Anaconda. Small lots of first-class sulphide lead ore were shipped from the Silver Tip, At Ease, and Payer claims, and a small quantity of rich siliceous gold ore from the Buckeye mine was treated locally by cyanidation.

Elkhorn district.—Three lode mines in the Elkhorn district produced 816 tons of ore and old tailings, which yielded \$3,160 in gold, 1,444 ounces of silver, and 1,975 pounds of copper, valued in all at \$4,289, or \$5.26 in metals a ton. With the exception of 68 tons of old tailings shipped for smelting the entire output was first-class ore. Most of the output—740 tons—was gold-bearing iron ore shipped by lessees from the Golden Curry mine; the ore is used as an iron flux at the East Helena smelter. A few cars of old tailings from the Elkhorn dump were shipped to a smelter, and lessees operating the Copper King property of the East Butte Copper Mining Co. shipped a small quantity of oxidized copper ore.

Lump Gulch district (Clancey).—Two placers and four lode mines in the Lump Gulch district produced 235 tons of ore, \$912 in gold, 3,333 ounces of silver, 724 pounds of copper, 59,258 pounds of lead, and 45,545 pounds of zinc, valued in all at \$9,181. The ore yielded on the average \$38.44 in metals a ton. The output consisted of 64 tons of first-class smelting ore and of 171 tons of milling ore, which was reduced to 84 tons of concentrates. The largest production in the district came from the White Pine mine, which produced several cars of lead-zinc ore that was shipped to Butte for milling. A car of gold ore was shipped early in the year from the Bell property, a car of sulphide lead ore was shipped from the Frohner mine, and a small lot of first-class silver ore was produced from the Little Nell claim. A little placer gold was recovered by sluicing gravel from claims in Lump Gulch near Clancey.

Mitchell district.—The John and Jim groups of the Economy Mines Co. were not worked in 1928 but a car of siliceous gold concentrate produced from former operations was shipped for smelting.

Pipestone district.—A small test lot of first-class sulphide lead ore containing considerable gold was shipped from the Blue Bell East & West Extension property. The ore is hauled 2 miles to Spire Rock, a station on the Northern Pacific Railroad. About 4,000 tons of milling ore averaging \$20 a ton is said to be blocked out.

Whitehall district.—Three lode mines in the Whitehall district produced 221 tons of ore, yielding \$804 in gold, 831 ounces of silver, 531 pounds of copper, and 60,547 pounds of lead, valued in all at \$4,878, or \$22.07 in metals a ton. The total value in 1927 was \$7,894. The entire output in 1928 was first-class smelting ore. The Perhaps mine, 6 miles from Whitehall, was worked throughout the year by a lessee who shipped four cars of oxidized lead ore to the smelter at East Helena. Lessees also operated the Sunny Corner property near Whitehall and shipped a few cars of sulphide and oxidized lead ore. Development in 1928 consisted of sinking a winze 60 feet and of driving a crosscut 45 feet. A small quantity of oxidized lead ore was produced from the Midnight claim.

JUDITH BASIN COUNTY

The value of the mine production of metals in Judith Basin County, largely from mines near Monarch, decreased from \$75,030 in 1927 to \$72,946 in 1928. For a number of years the Block P. property in the Barker district was the largest producer in the county. On February 24, 1927, the property was sold to the St. Joseph Lead Co., and shipments of concentrates were discontinued until November, 1928, when the new 400-ton flotation plant was completed and put in operation.

Barker district (Hughesville).—Four lode mines in the Barker district produced 5,609 tons of ore in 1928, yielding \$568 in gold, 31,618 ounces of silver, 8,150 pounds of copper, 527,311 pounds of lead, and 347,278 pounds of zinc, valued in all at \$72,005, or \$12.84 in metals a ton, compared with a total value of \$72,995 in 1927. The output consisted of 108 tons of first-class smelting ore and of 5,501 tons of concentrating ore which was reduced to 788 tons of concentrates. Most of the production came from the Block P. property of the St. Joseph Lead Co. where late in the year lead-zinc ore was treated in a new 400-ton flotation plant equipped with 2 crushers, rod mill, Dorr classifier, Dorr filters, 16 Fahrenwald flotation cells, 4 St. Joseph flotation machines, and 3 agitation tanks. An unusual amount of work was done at the property in 1928. The shaft was sunk an additional 506 feet, 7,656 feet of drifting was done, and an aerial tramway 2 miles long to carry ore from the mine to the mill was completed. Two cars of sulphide lead ore containing considerable silver from the Emerald mine were shipped to East Helena for smelting. Development in 1928 consisted of 200 feet of raising and of 500 feet of drifting. The Cape Nome mine near Hughesville was operated by a lessee who shipped a car of first-class sulphide lead ore. A 12-inch vein of high-grade ore averaging 250 ounces of silver to the ton and 38.8 per cent of lead is said to have been opened. A seam of limestone separates this rich ore from a 10-inch vein of low-grade ore averaging 50 ounces of silver to the ton and 30 per cent of zinc. A small quantity of sulphide lead ore of smelting grade was shipped from the Frenchman & Pocket group.

Yogo district.—Two test lots of first-class oxidized silver-lead ore were shipped by the Yogo Lead & Zinc Co. from its Hillside claim at the extreme head of Yogo Creek. The ore is hauled to Neihart, a station on the Great Northern Railroad. A little placer gold was recovered by sluicing at the Fourth of July claim.

LEWIS AND CLARK COUNTY

The value of the mine production of metals in Lewis and Clark County in 1928 was \$1,131,477 or more than four times that of 1927. The value of the output and the increase were larger than those in any county except Silver Bow (Butte district). The large increase in the output of lead and zinc was due to the treatment of current slag from the East Helena lead plant. There was also a large increase in the output of gold as a result of milling operations at the Spring Hill and New Gould properties.

Regular smelting operations were continued at the lead plant of the American Smelting & Refining Co. at East Helena, which is equipped with sampler, roasters, blast furnaces, bag house, and

Cottrell plant; no refining is done. About 6,300 tons of lead bullion a month was shipped east for refining. Custom material chiefly from Montana and Idaho was treated. A large part was sulphide lead ore and concentrate from the Coeur d'Alene region of Idaho. Residues from the zinc plants at Black Eagle and Anaconda derived from zinc products from Montana, Utah, Idaho, and other western States constituted a large part of the receipts. The following paragraph referring to the successful treatment of zinc-bearing slag at East Helena is taken from the report of the Anaconda Copper Mining Co. for 1928.

This plant operated satisfactorily, treating 68,127.05 tons of slag assaying 15.1 per cent zinc, from which there was produced 10,479.45 tons of fume assaying 71 per cent zinc, which was shipped to the electrolytic zinc plant at Great Falls, Mont.

The following description ⁸ was published in August.

The design of a suitable plant for East Helena, Mont., was begun in June, 1927. This plant now consists, in the first place, of a water-jacketed furnace 8 by 12 feet in area, having a charge hole at one end, into which the liquid slag from the A. S. & R. Co.'s lead furnaces, running 12 to 15 per cent zinc, is poured. Nothing but liquid slag and some skulls are treated in the plant to be described.

The plant treats about 300 tons of slag a day and consists chiefly of the rectangular furnace, brick flues, steel flues, U tubes, bag house, and machines for feeding crushed coal under pressure.

Bear Gulch district.—The Aurora property, a new mine 4 miles north of Rimini and 9 miles west of Helena, produced a small quantity of first-class gold ore containing a little silver, copper, and lead.

Dry Gulch district.—A small quantity of placer gold was recovered by drifting from the Oro claim in Oregon Gulch. At the Golden Messenger property, 23 miles northwest of Helena, considerable development was done in crosscutting, drifting, and tunneling; no shipments were reported. Most of the work was done in the No. 3 tunnel, where several veins were encountered and a large body of milling ore was opened.

Gould district.—The New Gould Mining Co. operated the Jay Gould mine and its 50-ton mill throughout the year and made an increased output of gold bullion and concentrate. More than 15,000 tons of gold ore was treated by amalgamation and table concentration. Considerable development was done in 1928; the main shaft was sunk an additional 100 feet, a 1,200-foot drainage tunnel was constructed, and 1,100 feet of work was done in the tunnels and raises. The mine again ranked fourth as a producer of gold in Montana.

Grass Valley district.—Four lode mines in the Grass Valley district produced 150 tons of ore, yielding \$329 in gold, 18,510 ounces of silver, 1,196 pounds of copper, and 23,053 pounds of lead, valued in all at \$12,666, or \$84.44 in metals a ton. The entire output was ore of smelting grade and most of it was oxidized lead ore rich in silver from the Silver Coin property operated by lessees. One small lot of ore averaged 383.85 ounces of silver to the ton. A car of first-class sulphide lead ore was shipped from the Rock Rose mine, a small lot of similar ore was shipped from the Last Chance claim, and a little silver-lead ore was produced at the Black Cat property.

Greenhorn district.—Two cars of sulphide lead ore from the King Tut property in Skelley Gulch near Austin were shipped to East Helena for smelting.

⁸ Laist, Alexander, Fuming Off Zinc from Lead Slags at East Helena: Eng. and Min. Jour., vol. 128, Aug. 24, 1929, p. 325.

Heddleston district.—The Blackfoot Silver-Lead Mining Co., leasing the Carbonate group on Big Blackfoot River 50 miles northwest of Helena, did 250 feet of drifting and 100 feet of crosscutting late in the year and started erecting an 80-ton selective flotation plant. No ore was shipped in 1928; it is expected, however, that a large production will be made in 1929. It is said that 50,000 tons of lead-zinc ore is available for milling. The Mike Horse mine, 33 miles northwest of Silver City, a large producer of silver, lead, and zinc in the past, was idle in 1928.

Helena (Unionville, Spring Hill) district.—Four lode mines in the Helena district produced 38,276 tons of ore, yielding \$101,365 in gold, 734 ounces of silver, and 4,552 pounds of lead, valued in all at \$102,058, or \$2.67 in metals a ton. The entire output, except 10 tons of ore of smelting grade, was gold ore treated by cyanidation. The Montana-Idaho Mines Corporation worked the Spring Hill property, 5 miles south of Helena, most of the year and treated 38,266 tons of gold ore in its new 200-ton cyanidation plant. The mine ranked third as a producer of gold in Montana in 1928. Development comprised 970 feet of raising, 490 feet of tunneling, 390 feet of drifting, and 140 feet of crosscutting. Ore in the upper levels consisted of gold in quartz with pyrite and arsenopyrite, but recent work has opened a large deposit of pyrrhotite containing gold, and tables and flotation cells will be substituted for cyanidation in 1929. A small lot of first-class silver-lead ore containing considerable gold was shipped from the Gold Asset mine and a test lot of rich gold ore from the Robinson claim.

Lincoln district.—Placer gold valued at \$249 was recovered from the Harvey property, 8 miles southwest of Lincoln in Sauerkraut Gulch.

Ottawa district (Marysville).—Five lode mines in the Ottawa district produced 8,485 tons of ore and old tailings, yielding \$51,998 in gold, 18,762 ounces of silver, and 177 pounds of copper, valued in all at \$63,000, or \$7.42 in metals a ton. The value of the output decreased from \$149,776 in 1927, as a result of the large decrease in the output of gold ore from the Drumlummon mine. Of the total output of the district in 1928, 5,850 tons was ore and 1,900 tons was old tailings treated by cyanidation, 50 tons was ore treated by amalgamation, and 685 tons was first-class smelting ore. Most of the production came from the Drumlummon and Nine Hour claims of the St. Louis Mining & Milling Co. More than 6,000 tons of gold ore and old tailings from this property was treated in an 80-ton cyanide plant, and about 1,500 tons of old tailings from the Drumlummon dump was treated by cyanidation in the Aagaard plant and yielded gold and silver bullion.

The mine was operated 9 months of the year, but the mill was active only 6 months as the management directed most of its effort toward opening up a portion of the mine which had been idle for 15 years. Work done in 1928 consisted of driving 1,097 feet of raises and tunnels in new ground, and of retimbering and repairing old caved workings for a distance of 2,183 feet. The property ranked fifth as a producer of gold in Montana in 1928.

Lessees operated the old Piegan-Gloster property, formerly a large producer, and shipped more than 500 tons of first-class gold ore for smelting. A little gold bullion produced from former operations at the Gleason property was marketed in Helena. The Honeycomb

mine, $4\frac{1}{2}$ miles southwest of Marysville, was worked by lessees, who shipped a car of rich gold and silver ore to Anaconda for smelting. The Home Mining & Milling Co. worked its claims 6 miles from Marysville and did 150 feet of upraise and 30 feet of drifting, but no ore was produced.

Seven Mile district.—The Helena Silver-Lead Mines was organized early in the year to operate claims 8 miles from Helena. After sinking a vertical shaft 220 feet deep and drifting 150 feet the company reported opening a large body of milling ore.

Stemple district.—A little gold ore from the Klondike property was treated by amalgamation, and a test lot of similar material from the Golconda claim of the Nakoma Mines, 15 miles north of Silver City, was shipped to the smelter at East Helena. The company is driving a 200-foot crosscut to intersect a vein of high-grade gold ore.

Vaughn district (Rimini).—Three lode mines in the Vaughn district produced 27 tons of ore, yielding \$141 in gold, 1,059 ounces of silver, 43 pounds of copper, and 26,197 pounds of lead, valued in all at \$2,286, or \$84.67 in metals a ton. The entire production was rich silver-lead ore of smelting grade which came from the Loeber Lode, Lee Mountain, and Silver Queen properties. The Montana Lead (Inc.) is driving a long crosscut tunnel to develop several groups of claims on Red Mountain 18 miles southwest of Helena.

Wolf Creek district.—The production of the Wolf Creek district consisted of two small shipments of first-class sulphide copper ore, one from the New Era property of the Montana Copper & Zinc Co. and one from the Tullock claim. The ore, containing chiefly chalcopyrite, is hauled 5 miles to Wolf Creek, a station on the Great Northern Railroad.

LINCOLN COUNTY

The value of the mine production of metals in Lincoln County decreased from \$65,050 in 1927 to \$25,248 in 1928 as a result of the large decrease in the output of lead-zinc ore from the Snow Storm and Big Eight properties. The output of all metals except gold decreased. There was a large output of vermiculite, a variety of mica which is ground and roasted for use as an insulator.

Libby district.—Four lode mines in the Libby district produced 1,291 tons of ore yielding \$14,981 in gold, 2,501 ounces of silver, 185 pounds of copper, and 33,689 pounds of lead, valued in all at \$18,425, or \$14.27 in metals a ton. The output consisted of 1,000 tons of ore treated by amalgamation and concentration, 161 tons of first-class smelting ore, and 130 tons of concentrating ore which was reduced to 42 tons of concentrate. The Midas Gold Mining & Milling Co., operating the Rose property, 36 miles south of Libby on the Great Northern Railroad, treated about 1,000 tons of low-grade gold ore for testing purposes in the 75-ton plant equipped with amalgamation plates, crushers, ball mill, Dorr classifier, flotation cells, tables, cyanide tanks, and magnetic separator. A number of alterations were made to improve the milling process and to increase the capacity of the mill. The company plans to do considerable development before resuming milling operations on a regular basis. The mine is developed by an adit tunnel, a winze 135 feet deep from the adit tunnel, and 1,340 feet of drifts. Work in 1928 included 215 feet of drifting, opening up eight stopes, sinking the winze an additional 35

feet, and retimbering 800 feet of drifts. In addition to free gold the ore contains galena, cerussite, scheelite, tetrahedrite, and pyrite. Operators at the Gold Standard property, 40 miles south of Libby, shipped several cars of rich gold ore of smelting grade, containing a little copper and lead. Development was continued, a compressor was installed, and a concentration mill is planned for 1929. The Lukens Hazel property and the flotation mill of the Glacier Silver-Lead Mining Co., 8 miles south of Libby, were operated a short time, and one car of lead concentrate and one car of first-class oxidized lead ore were shipped to East Helena for smelting. A new body of milling ore was said to have been opened. A small quantity of ore from the Tip Top mine, 35 miles south of Libby, was milled and yielded lead concentrate containing an average of 3 ounces of gold to the ton. A 1,450-foot aerial tramway was erected, and a large body of ore averaging \$3.40 a ton in gold has been developed.

Troy or Callahan Creek district.—Three lode mines in the Troy district produced 169 tons of ore, yielding \$138 in gold, 1,003 ounces of silver, 105 pounds of copper, 66,126 pounds of lead, and 36,843 pounds of zinc, valued in all at \$6,823, or \$40.37 in metals a ton. The output consisted of 44 tons of first-class smelting ore and of 125 tons of milling ore which was reduced to 57 tons of concentrate. Lessees operated the Snow Storm property of the Snow Storm Silver-Lead Co. and shipped three cars of lead-zinc ore to Butte for custom milling and two cars of first-class sulphide lead ore to East Helena for smelting. A car of lead-zinc ore from the Big Eight property was shipped for testing purposes to the Hercules mill at Wallace, Idaho, and a small lot of sulphide lead ore from the Pathfinder group, 7 miles south of Troy on Grouse Mountain, was shipped to a smelter. The Liberty Metals Co. worked its property the entire year, but no ore was marketed. Development consisted of sinking the shaft an additional 105 feet, of driving the tunnel 215 feet, and of diamond drilling 186 feet. This work is said to have opened 14 inches of ore containing between \$400 and \$500 in gold to the ton. Development was continued at the property of the Montana Sunrise Mining Co. and a large body of lead-zinc ore was opened.

MADISON COUNTY

The quantity of ore and the output of all metals in Madison County, especially gold and lead, increased in 1928. The total value of the output increased from \$246,433 in 1927 to \$347,881 in 1928, chiefly because of the increase in the output of gold from the property of the Liberty Montana Mines Co. This property, 15 miles south of Jefferson Island, again ranked second as a producer of gold in Montana. There was a large increase in the output of lead from the Calvin mine near Melrose, operated by the Commonwealth Lead Mining Co.

Alder Gulch district (Virginia City).—Three placers and three lode mines in the Alder Gulch district produced 18 tons of ore and old slag, \$3,421 in gold, 500 ounces of silver, and 896 pounds of lead, valued in all at \$3,765. The ore and old slag yielded on the average \$58.67 in metals a ton and consisted chiefly of a test lot of gold ore of milling grade and a few tons of sulphide silver-lead ore of smelting grade from the Alhambra mine. A small lot of rich gold ore from

the Lead Star mine was shipped for smelting, a little slag from the old Gilman dump was treated by amalgamation, and gold bullion valued at \$557 was sent to the assay office at Helena. Sluicing and drifting operations on placer claims in Alder Gulch, including the Chambers placer, produced gold and silver bullion valued at \$2,709. The Alder Gulch Mining Co. was organized in June to take over 2,000 acres of placer ground at Alder Gulch, 2 miles south of Virginia City. A 30-ton steam shovel was installed and preliminary work done in testing the ground.

Bone Basin district.—Four lode mines in the Bone Basin district produced 35 tons of ore, which yielded \$816 in gold, 49 ounces of silver, and 2,736 pounds of copper, valued in all at \$1,239, or \$35.40 in metals a ton. The entire output was first-class ore of smelting grade and consisted of small lots of fairly rich gold ore from the Davis, Colorado, and Independent properties and of a few tons of sulphide copper ore from the Florence property.

Lower Hot Springs district (Norris).—Three lode mines in the Lower Hot Springs district produced 141 tons of ore, yielding \$885 in gold, 42 ounces of silver, and 198 pounds of lead, valued in all at \$921, or \$6.53 in metals a ton. The entire output was gold ore, most of which was mined at the Birdia property by the Stoker Mining Co. and treated in a 30-ton amalgamation mill. The mine was operated six months, and 215 feet of development was done in tunneling and raising. The Empire Mines Co., owning property 4 miles west of Norris, treated a few tons of gold ore in a 150-ton flotation plant and shipped a small quantity of concentrate averaging 5.5 ounces of gold to the ton. The mill was destroyed by fire in December, but the company planned to rebuild it in 1929. A little gold ore from the Boaz mine was also treated and a small lot of concentrate shipped to Anaconda for smelting. Development was continued at the Eagle Point, Josephine, Midnight, Red Cross, Stratton, Gold Bond, and Valdez claims.

McCarthy Mountain district.—Three lode mines in the McCarthy Mountain district produced 64 tons of ore, yielding \$5,970 in gold, 1,635 ounces of silver, 326 pounds of copper, and 8,391 pounds of lead, valued in all at \$7,460, or \$116.56 in metals a ton. The entire output was first-class smelting ore and consisted of oxidized lead ore and siliceous gold ore. The Hidden Treasure property, 9 miles from Glen, a loading station on the Oregon Short Line Railroad, produced three lots of gold ore, one of which contained more than 11 ounces of gold to the ton. A lessee operated the Bessie mine and shipped a car of oxidized lead ore. A small lot of lead ore, containing 193 ounces of silver to the ton, was marketed from the Vermont mine near Glen.

Mineral Hill district.—Four lode mines in the Mineral Hill district produced 35,415 tons of ore, yielding \$190,998 in gold, 16,665 ounces of silver, and 199,429 pounds of copper, valued in all at \$229,465, or \$6.48 in metals a ton. The output consisted of 84 tons of first-class smelting ore, 60 tons of ore treated by amalgamation, and 35,271 tons of concentrating ore which was reduced to 1,631 tons of concentrates. Most of the production came from the Mammoth property of the Liberty Montana Mines Co., 16 miles south of Jefferson Island. The mine was operated most of the year, and the 100-ton plant equipped with a crusher, ball mill, tables, and flotation cells treated more than 35,000 tons of copper ore that yielded copper concentrate

rich in gold. The mine ranked second as a producer of gold in Montana in 1928. After paying freight and treatment charges the company received \$188,067. Development in 1928 consisted of 2,000 feet of drifts and crosscuts and 230 feet of raises. Lessees operated the Boss Tweed mine and shipped three cars of first-class smelting ore averaging 3 ounces of gold to the ton. A little gold ore of smelting grade was also produced from the Oregon property, and a little gold bullion was sold as a result of a clean-up at the old amalgamation plant on the Clipper property. In November the Boss Tweed and Clipper properties were taken over by W. A. Clark, jr., and work was started to open a large deposit of low-grade gold ore containing copper, which will be treated by the flotation process.

Rabbit district.—Three lode mines in the Rabbit district produced 1,863 tons of ore, yielding \$3,071 in gold, 30,379 ounces of silver, 4,692 pounds of copper, and 822,534 pounds of lead, valued in all at \$69,226, or \$37.16 in metals a ton. The output consisted of 1,463 tons of first-class smelting ore and of 400 tons of concentrating ore which was reduced to 99 tons of concentrates. Most of the smelting ore was oxidized lead ore from the Calvin (Avonca) mine, 6 miles east of Melrose, operated by the Commonwealth Lead Mining Co. The ore contained an average of 20 ounces of silver to the ton, 27.6 per cent of lead, and a little copper and gold. Development in 1928 opened a large body of high-grade silver-lead ore, and the company plans to construct a mill to treat a large quantity of low-grade ore. The Jack Rabbit property, 5 miles northeast of Melrose and south of Camp Creek, was operated by the owners during the first 5 months of the year, and 5 cars of oxidized silver-lead ore were shipped for smelting. In June the Standard Silver-Lead Co. was organized to operate the property under lease and option but after considerable development work had been done and two cars of ore had been shipped the property was returned to the owners. The Emma mine, 11 miles southwest of Twin Bridges, was operated the entire year by the Emma Mine (Inc.). A few hundred tons of sulphide lead ore was treated by gravity concentration; the resulting concentrate, together with a car of first-class silver-lead ore, was shipped to East Helena for smelting. The mine is developed by an incline shaft 570 feet deep and by 1,500 feet of drifts. In 1928 considerable work was done in sinking and drifting, and a 60-ton mill equipped with three tables and an 8-cell flotation machine was completed and operated; no ore was treated by flotation. On January 1, 1929, the property was purchased by the Butte-Madison Mines Corporation and plans were made for operating the new mill.

Ramshorn district.—One placer and four lode mines in the Ramshorn district produced 37 tons of ore, \$3,751 in gold, and 702 ounces of silver, valued together at \$4,162. The ore was all first-class smelting ore; it yielded on the average \$101.41 in metals a ton. The output consisted of small shipments of rich gold ore from the Goldsmith, Pedro, and Gold Queen properties, a little gold and silver ore from the Ellajay mine, and a little gold from the McKay placer in Bivens Gulch.

Sheridan district.—Eight lode mines in the Sheridan district produced 786 tons of ore, yielding \$12,011 in gold, 3,568 ounces of silver, 2,177 pounds of copper, 26,099 pounds of lead, and 11,175 pounds of zinc, valued in all at \$16,607, or \$21.13 in metals a ton, compared

with a total value of \$11,850 in 1927. Most of the output (640 tons) was concentrating ore which yielded 103 tons of concentrates; the remainder (146 tons) was first-class smelting ore. The Gladstone Mines & Reduction Co. operated the Gladstone mine most of the year. The 100-ton milling plant equipped with Wilfley tables was operated only the first four months; it treated several hundred tons of gold ore. Three cars of concentrate, averaging nearly 4 ounces of gold to the ton, were shipped to Anaconda for smelting. Besides doing considerable development in the Gladstone property the company is driving a 1,300-foot tunnel in the Leiter mine near by. Lessees worked the Buckeye mine and shipped several cars of lead-zinc ore to the custom flotation mill at Butte. Three cars of siliceous gold ore from the Red Pine property were shipped to Anaconda for smelting. The Nettie mine, 12 miles northeast of Sheridan, produced a small quantity of ore averaging 8 ounces of gold and 50 ounces of silver to the ton. The Silver Bullion mine, $8\frac{1}{2}$ miles east of Sheridan, produced a small quantity of ore averaging 120 ounces of silver to the ton. Small lots of first-class lead ore from the Jonquil, Tipirary, and Empire claims were shipped to the East Helena smelter. At the Emma B. and Glenora claims of the Smuggler Mining Co. considerable development was done, from May to December, in cross-cutting and drifting and it was reported that 10,000 tons of gold ore were on the dump at the end of the year. New mine equipment was installed, 4,000 feet of water pipe were laid, a complete camp was built, and construction was begun on a 100-ton milling plant to be equipped with amalgamation plates, tables, and flotation cells.

Silver Star district.—Three lode mines in the Silver Star district produced 203 tons of ore, yielding \$3,906 in gold, 169 ounces of silver, and 157 pounds of copper, valued in all at \$4,027, or \$19.84 in metals a ton. Lessees operating the Broadway mine shipped four cars of gold ore of smelting grade containing a little copper and silver. A car of first-class gold ore was also shipped from the Edgerton claim. A lessee operated the Strawn property and shipped a few tons of first-class gold ore early in the year; in October the Jodie Mining & Developing Co. was organized to operate the property under lease. The company erected a 5-stamp amalgamation mill and treated nearly 100 tons of gold ore.

Summit district (Virginia City).—The Mountain Flower property, 10 miles from Alder, was not worked in 1928, but 75 tons of old tailings treated by cyanidation yielded precipitates containing gold and silver which were sent to the assay office at Helena.

Tidal Wave district (Twin Bridges).—Nine lode mines in the Tidal Wave district produced 117 tons of ore, yielding \$8,712 in gold, 769 ounces of silver, 519 pounds of copper, and 22,257 pounds of lead, valued in all at \$10,528, or \$89.98 in metals a ton, a decrease from \$20,297 in 1927. The largest output was that of the Corncracker property operated by lessees who shipped two small cars of first-class ore averaging more than 6 ounces of gold to the ton. The ore is hauled 8 miles west to Twin Bridges, a station on the Northern Pacific Railroad. Rich gold ore of smelting grade was also shipped from the Pete & Joe, High Ridge, June, and High Peak properties. The Isabelle claim in Bear Gulch produced a small quantity of first-class copper-lead ore containing considerable gold and silver, the Dutchland mine produced a car of sulphide lead ore, and the Ella mine pro-

duced a small car of oxidized lead ore containing considerable gold. A small lot of first-class lead ore was also produced from the Texas claim. A new 300-ton mill was being constructed on the property of the Mohave Mining Corporation, but no development was done in the mine. A large body of gold ore is said to be blocked out awaiting the completion of the mill.

Washington district (Meadow Creek).—The Montana Lead & Zinc Co. worked its property near McAllister throughout the year and opened a large body of ore averaging \$15 in gold to the ton. The company completed 11 miles of road work, drove a crosscut tunnel 200 feet, and drew plans for a new cyanidation plant.

MEAGHER COUNTY

Musselshell district.—Lessees operating the Mammoth property, formerly the Copper State claim of the Montana Copper & Zinc Co., shipped a car of lead-zinc ore to the custom flotation plant at Butte. The ore is hauled 17 miles southwest to White Sulphur Springs, a station on the Chicago, Milwaukee, St. Paul & Pacific Railroad.

MINERAL COUNTY

The value of the mine production of metals in Mineral County decreased from \$27,369 in 1927 to \$17,940 in 1928, chiefly because of the decrease in the output of lead and zinc from the Iron Mountain property, 4 miles north of Superior.

Cedar Creek district (Iron Mountain, Quartz).—Seven placers in the Cedar Creek district produced gold and silver valued at \$2,128. The gold is exceptionally pure, some if it having a fineness of 0.987. Most of the output was recovered by sluicing at the Eddy placer (operated by the Higley Mining Co.) on Deep Creek, the Stockholm, and the Windfall claims; there was also a small production from the C. B. & Q., Ohio, and Stemwinder claims and from a placer on Quartz Creek. At the Meadow Creek placer claim of the Big Nuggett Mining Co., 3 miles west of Quartz, considerable work was done in laying 3,000 feet of pipe and preparing for hydraulic and sluicing operations; no gold was recovered as there was a shortage of water.

Iron Mountain district (Superior, Iron Mountain).—The 125-ton flotation plant on the Iron Mountain property, $3\frac{1}{2}$ miles north of Superior, was idle, but nearly 400 tons of lead-zinc ore containing considerable silver was shipped to Butte for custom milling. The Iron Mountain Mining Co. operated the property under lease and purchased it during the year from the Federal Mining & Smelting Co. In June the Mines Development Co. of Washington began operating the Klondyke, Golden Treasure, and Michigan placer claims on Oregon Creek and drove an 850-foot tunnel to open gravel at a depth of 20 feet.

Keystone district (Spring Gulch).—At the King & Queen group, 6 miles west of Superior, development was continued by the Amalgamated Metals Mines Co., and a car of lead-zinc ore was shipped as a test to Butte for custom milling.

St. Regis district.—The Rock Island and Valentine properties, formerly operated by the Lead Hill Mines Corporation, were taken over by the Western Consolidated Mines Corporation and about \$3,000 was spent in development; no ore was marketed. The

Richmond-Lexington Mining & Milling Co. worked its property near Deborgia, and in December a body of commercial ore averaging 12 per cent of copper and a little gold, silver, and lead was opened.

Saltese district.—The Silver Cable Mining Co. was organized in June to operate the Silver Cable mine near Taft. It is reported that 350,000 tons of ore averaging 3.5 ounces of silver to the ton, 16 per cent of zinc, and 4 per cent of lead is blocked out and the company is planning a 200-ton flotation plant. Development was continued at both the Boston Colby and Last Chance properties.

MISSOULA COUNTY

Nine Mile district.—A little gold was recovered by hydraulic operations at a placer claim on McCormick Creek.

Potomac district.—The Charcoal mine, 5 miles south of Potomac, which was formerly operated by the Royal Mining Co., produced 15 tons of lead-zinc ore containing considerable silver. The ore is hauled 11 miles west to McNamara, a station on the Chicago, Milwaukee, St. Paul & Pacific Railroad, and shipped to Butte for custom milling. The mine is opened by a 2-compartment shaft 202 feet deep and by 3 tunnels. Development in 1928 consisted of opening an old crosscut 420 feet long and of doing considerable drifting.

PARK COUNTY

The value of the mine production of gold and silver in Park County decreased from \$2,388 in 1927 to \$88 in 1928. In 1925 the value of the mine production, chiefly from gold-arsenic ore of the Jardine mine, was \$294,248. This mine was practically idle in both 1927 and 1928.

Sheepeater district (Jardine).—The Jardine mine, a large producer of both gold and arsenic in 1926, was not operated in 1927 or 1928, but some arsenic from former operations was marketed. A little gold ore from the Margaret claim near Crevasse was treated by amalgamation.

New World district (Cooke City).—The Irma Mines (Inc.) continued to develop its property near Cooke City, and it was reported that a deposit of first-class silver-lead ore was opened.

PHILLIPS COUNTY

The mine production of metals in Phillips County was valued at \$5,058 in 1928, an increase of \$2,546 over that in 1927. The chief output of the county was siliceous gold ore from the Beaver Creek mine. In 1923 the value of the mine production was \$286,803, chiefly from gold ore of the Ruby Gulch mine.

Little Rockies district.—One placer and four lode mines in the Little Rockies district produced 1,549 tons of ore and old cleanings, \$4,618 in gold, 740 ounces of silver, and 122 pounds of lead, valued in all at \$5,058. The ore and cleanings averaged \$3.22 in metals a ton. Most of the output was siliceous gold ore from the Beaver Creek property treated by cyanidation. The mine was worked virtually all the year, and development consisted of 200 feet of drifting and 100 feet of raising. The Ruby Gulch mine was not operated, but gold bullion recovered from a clean-up was marketed. Some material

containing gold and silver and a little lead recovered from a few tons of old mill cleanings was shipped to East Helena for smelting, and a little gold was recovered from a placer claim in Alder Gulch near Zortman.

POWELL COUNTY

The mine production of metals in Powell County was valued at \$12,284 in 1928, a decrease of \$16,757 from the output of 1927. The decrease was general, and the placer mines near Gold Creek were not as active as in the past.

American Gulch district.—A little gold was recovered at a placer claim in American Gulch near Finn.

Big Blackfoot district.—Placer gold and silver valued at nearly \$2,000 was recovered from the Gold Dust (McCormick) property on Ogden Mountain near Ovando. The property was worked about two months by hydraulic mining.

Blossburg district.—A little gold ore from property on the Northern Pacific tract near Elliston was treated in a small amalgamation mill.

Nigger Hill district (Elliston).—Three lode mines in the Nigger Hill district produced 8 tons of ore, yielding \$138 in gold, 215 ounces of silver, 41 pounds of copper, and 4,000 pounds of lead, valued in all at \$501, or \$62.63 in metals a ton. The entire output was small lots of first-class lead ore from the Telegraph, Flora, and Charter Oak properties.

Pioneer district (Gold Creek).—Six placers and five lode mines in the Pioneer district produced 106 tons of ore, \$7,823 in gold, and 110 ounces of silver, valued together at \$7,887. The ore averaged \$37.96 in metals a ton and was all siliceous gold ore. Most of it was treated by amalgamation and came from the Pioneer and Independence properties near Gold Creek. The Independence mine, 16 miles south of Gold Creek, was worked about eight months and 250 feet of drifting was done. Small quantities of gold ore from the Fourth of July and Kraes claims were concentrated and rich gold concentrate was shipped to Anaconda for smelting. The placer output, valued at \$3,863, was the largest placer production for any mining district in Montana in 1928 and was recovered chiefly at the Friday and Pioneer claims.

Zozell district (Emery, Deer Lodge).—A little prospecting was done at the Blue Eyed Maggie property, 9 miles east of Deer Lodge, and one car of fairly rich gold and silver ore was shipped to Anaconda for smelting. The Harvey Creek Mining Co. did considerable development in 1928 on the Hiddenhand group, 10 miles east of Deer Lodge. The company opened a deposit of first-class silver-lead ore but no shipments were made.

RAVALLI COUNTY

Overwich district (Hughes Creek).—The output of the Overwich district was small compared with that of past years; it consisted of placer gold from a claim on Hughes Creek.

SANDERS COUNTY

Burns district.—The Princess Gold Mining Co. worked the Iron Daisy property eight months and opened a deposit of silver-lead ore. The company is planning the construction of a 50-ton flotation plant.

Thompson River district.—A lessee worked the Silver King mine, 9 miles from Thompson Falls, and shipped a car of sulphide silver-lead ore of smelting grade. In August the Lloyd Mining Co. was organized to work the mine, and it was reported that a body of first-class silver-lead ore was opened.

SILVER BOW COUNTY

Forty-three mines in Silver Bow County were productive in 1928, but most of the metal output resulted from the operations of five companies at Butte. Although nearly all the large producing mines at Butte were active throughout the year the output of all metals except gold and copper decreased considerably, especially zinc. The output of copper increased nearly 26,000,000 pounds on account of the increase in the market price of the metal. The larger part of the ore and old tailings mined or treated was concentrated at custom milling plants at Butte and Anaconda; the resulting products consisted of copper concentrates, lead concentrates, and zinc concentrates. These yielded metals valued at \$49,755,819, or \$72.95 a ton of concentrates. The crude smelting ore yielded on the average \$15.46 in metals a ton. No ore was treated by amalgamation or cyanidation. Old copper tailings, slag, and slime-pond material, amounting to 26,838 tons, were smelted. Of the total output of ore, old tailings, etc., in the county 80.5 per cent was classified as copper material.

Mine production of gold, silver, copper, lead, and zinc in Silver Bow County, Mont., 1927 and 1928

Year	Mines producing	Ore, old tailings, etc.	Gold (lode and placer)	Silver (lode and placer)	Copper ¹	Lead	Zinc	Total value
		<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1927-----	45	3,753,246	\$543,939	9,659,142	221,311,535	25,537,495	156,627,681	\$46,645,518
1928-----	43	3,896,048	596,781	9,558,619	247,066,962	24,660,285	147,896,033	52,218,170

¹ Includes copper recovered from precipitates, as follows: 1927, 4,515,407 pounds; 1928, 6,701,580 pounds.

Divide Creek district.—A small lot of rich gold ore from the Alice property near Melrose was shipped to the lead smelter at Midvale, Utah.

German Gulch district.—A little placer gold was recovered from claims in German Gulch.

Summit Valley or Butte district.—Forty-one lode mines in the Summit Valley district produced 3,896,046 tons of ore, old tailings, etc., which yielded \$595,495 in gold, 9,558,587 ounces of silver, 247,066,962 pounds of copper (including 6,701,580 pounds from precipitates), 24,660,285 pounds of lead, and 147,896,033 pounds of zinc, valued in all at \$52,216,865. Excluding the value of the copper recovered from precipitates the ore, old tailings, etc., yielded on the average \$13.15 in metals a ton. In 1927 the total value of the metal output was \$46,641,874. In 1928 the output consisted of 84,184 tons of first-class smelting ore, 26,838 tons of old tailings and pond slimes smelted, and 3,785,034 tons of concentrating ore which was reduced to 682,024 tons of concentrates. The mines at Butte have been large producers for more than 40 years, and rich ore is still being mined at great depth.

From the beginning of activities in 1882 to the end of 1928 Silver Bow County, which includes the Butte district, has yielded gold, silver, copper, lead, and zinc, valued at \$2,053,722,251, as follows: Gold, \$36,273,707; silver, \$320,617,161; copper, \$1,477,852,731; lead, \$19,723,930; and zinc, \$199,254,722. These values represent 1,754,740.53 ounces of gold, 441,648,535 ounces of silver, 9,610,821,172 pounds of copper, 292,730,427 pounds of lead, and 2,438,327,448 pounds of zinc.

According to the printed annual report for 1928, the mines of the Anaconda Copper Mining Co. produced 3,013,495 tons of copper ore and precipitates and 18,159 tons of zinc ore, a total of 3,031,654 tons in 1928, against 2,956,003 tons and 16,519 tons, respectively, a total of 2,972,522 tons in 1927. The chief producing mines of the company in 1928 were the Anaconda, St. Lawrence, Mountain Con, Bell, Belmont, Original, Stewart, Tramway, Leonard, West Colusa, Badger State, Anselmo, and Elm Orlu. The concentrators treated 2,975,206 tons of copper ore and 416,388 tons of zinc ore. The Anaconda works treated 648,940 tons of copper material and produced 247,577,554 pounds of fine copper, 6,165,123 ounces of silver, and 36,563.82 ounces of gold, and the greater part of this output came from the copper mines of the Anaconda Copper Mining Co. at Butte. A large quantity of silver and copper was recovered by the treatment at Anaconda of old tailings and slimes from ponds near the smelter.

The company owns a large area at Butte and works other property under lease, such as the Emma mine; it obtained control of the Anselmo mine in 1926 and purchased all the Clark interests, including the Elm Orlu, Poser, and Moulton, and other property at Butte in 1928. A general description of the geology, mining methods, underground workings, and reduction works is given in *The Mines Handbook*,⁹ and the mining, milling, smelting, and refining methods were reviewed¹⁰ in August, 1929.

The electrolytic copper refinery at Great Falls produced 263,141,497 pounds of cathodes, most of which were melted into shapes and rolled into rods and wire at Great Falls. The rod and wire mill at Great Falls rolled 164,331,731 pounds of copper into rods; 44,445,199 pounds of rods were drawn into wire, of which 16,337,054 pounds were made into strand. In addition to the rods used locally 37,218,686 pounds of rods were shipped from the mill to the Kenosha plant of the American Brass Co. to be drawn into wire.

During the year 704,169 tons of zinc ore and concentrates were treated in the zinc plants. Of this amount 17,865 tons of ore was from the mines of the company and 686,304 tons of ore and concentrates were purchased from other producers in Montana, Utah, and Idaho. The electrolytic zinc plants at Anaconda and Great Falls produced 321,122,464 pounds of slab zinc, 16,303,797 pounds of zinc in dross, and residue from which were recovered 24,524,208 pounds of lead, 2,575,697 pounds of copper, 3,887,285 ounces of silver, and 10,989.53 ounces of gold. Dividends amounting to \$14,419,034 were paid in 1928 by the Anaconda Copper Mining Co., and the net income for the year was \$24,174,781, which, added to the balance at

⁹ Neale, W. G., *The Mines Handbook*: Vol. 17, 1926.

¹⁰ Anaconda Number, Eng. and Min. Jour., vol. 128, Aug. 24, 1929.

the end of the year 1927, gives a surplus of \$99,703,599 after deduction of dividends. The company's annual report says:

The outstanding development of the copper industry during the year 1928 was the extraordinary increase in domestic consumption which developed during the second quarter and continued throughout the year.

In August the company purchased from interests representing the heirs of the late Senator Clark, all of their mining, milling, and lumber interests located in Montana and Idaho, together with the Butte Electric Railway Co. and the Montana Hardware Co., for the sum of \$4,456,824.58.

In construction work, the company spent \$1,250,985 for the Butte Mines; \$1,253,188 for Reduction Works, Anaconda; \$170,994 for Reduction Works, Great Falls; and \$71,677 for Slag Treating Plant, East Helena.

Drifts, crosscuts, raises, winzes, and shafts in the development work of the company were extended 34.60 miles, as compared with 30.67 during the year 1927, an increase of 12.81 per cent.

As in the past the company also did a large business in lumber, coal, fertilizer, arsenic, and sulphuric acid in Montana; in manufacturing and refining in the east; in mining, milling, and smelting in Utah, Arizona, California, and Colorado; and in mining and milling in South America and Europe. The present methods of mining, hauling, hoisting, ventilating, and other important phases of operations at the Butte mines are described in an article ¹¹ by the manager of mines.

The Anselmo property, owned by the Anaconda Copper Mining Co., was worked throughout the year and produced 28,629 tons of copper ore and precipitates and 1,875 tons of zinc ore, both milled at Anaconda. The chief product was copper concentrate, smelted at Anaconda, and zinc concentrate, treated in the electrolytic plants. Although the production decreased considerably in 1928, the mine ranked third as a producer of copper and tenth as a producer of silver in Montana.

The Emma mine of the Butte Copper & Zinc Co. continued to be operated by the Anaconda Copper Mining Co.; its production was considerably increased in 1928. The chief output of the mine was lead-zinc ore, which was shipped to Anaconda for milling. The high-grade lead concentrate is separated and shipped to East Helena for smelting, and the zinc product is shipped to the electrolytic plants at Great Falls and Anaconda. The property was again the largest producer of lead in Montana; it was third in the production of zinc, fourth in the output of silver, and seventh in gold in 1928. About 21,300 tons of manganese ore was also produced at the property and shipped to eastern steel plants or treated locally at Butte. From 154,869 tons of lead-zinc ore and manganese ore the Butte Copper & Zinc Co. received \$215,375; it received \$87,171 in 1927. The net income for 1928 was \$186,159, but no dividends were paid. The following paragraph is taken from the printed report of the Butte Copper & Zinc Co. for 1928.

The underground developments during the past year have been most satisfactory. On the 1,200-foot level the longest and richest ore bodies ever discovered in the properties were opened up. Our engineers assure us that the 1,400 and 1,600 foot levels when developed should produce large bodies of high-grade ores. Below the 1,400-foot levels at the present time high-grade ore bodies have been discovered. Crosscutting has been started on the 1,600-foot level and we hope shortly to cut the vein at this depth.

¹¹ Daly, William B., *Evolution of Mining Practice at Butte*: Eng. and Min. Jour., vol. 128, Aug. 24, 1929, p. 280.

The Black Rock property of the Butte & Superior Mining Co. was worked throughout the year and produced zinc ore and copper ore, which was treated in the flotation plants at Anaconda. A decided decrease was recorded in the output of zinc ore, and also a decrease in the output of copper ore. The property was again the largest zinc producer in Montana, but the output was nearly 17 per cent less than that in 1927. The property was second in the production of silver and lead, fourth in copper, and sixth in gold. During the year the company paid dividends amounting to \$580,395 or a total of \$19,697,135 to date. As a result of ore sales the company received \$2,117,876, compared with \$2,670,697 in 1927. The cost of mining, development, and general expense was \$2,064,963, leaving an operating profit of \$52,913, compared with \$309,894 in 1927. The net income, without deduction for depletion, was \$81,453, compared with \$272,911 in 1927. The following paragraphs are taken from the company's printed report for 1928.

Development work consisted of 22,380 feet of drifts and crosscuts, 6,103 feet of raises and 225 feet of shaft and station development.

No. 3 main hoisting shaft was deepened for two full compartments and man-way, to a point 84 feet below the 3,600 level, an advance of 68 feet for the year.

The program of developing additional ore in the Rainbow and other veins in the old workings of the mine from the 1,600 level upward, was continued during the year with very satisfactory results. The 1,400, 1,500 and 1,600 levels were reopened and developed during the year. A total of 176,010 tons was developed above the 1,600 level, of which 70,621 tons came from the abandoned ore bodies estimated at the beginning of the year to be available and the balance of 105,389 tons was ore not heretofore considered available. A further study was made of these old ore bodies and additional tonnage estimated in this connection, so that despite transfers to the commercial zinc ore reserves, there remained in the abandoned ore reserve at the end of the year 189,874 tons with an estimated assay of 6.67 ounces of silver to the ton and 15.67 per cent of zinc. It is believed that this tonnage will be increased by further exploration and study. Zinc development was continued below the 1,600 level and resulted in the adding of 60,391 tons to ore reserves. The total tonnage developed during the year amounted to 236,401 tons. * * *

The exploration of the Rainbow Lode and other veins on the 3,400 and 3,600 levels was continued during the year. A total of 1,625 feet of drifting and crosscutting was done on these two levels and with the exception of small sections, no commercial ore was encountered or developed. * * *

As forecast in the annual report for 1927, the copper ore reserves were depleted during the year 1928. In the last quarter of the year, preliminary work and preparations were toward leaching the filling in the copper vein and enough was done to show that this would be profitable, and during the year 1929 cement copper will be produced. * * *

The following is an estimate of ore reserves as of December 31, 1928: 151,924 tons of zinc ore, averaging 5.28 ounces of silver to the ton and 15.03 per cent of zinc. * * *

In addition to the above there are 141,405 tons of low-grade zinc ore and 23,485 tons of low-grade copper ore, which ores are unprofitable to mine at the present metal prices.

The foregoing statement of tonnage does not include 189,874 tons of zinc ore remaining in the old ore bodies at the end of the year. These can not be developed sufficiently to permit accurate measurement, except as they are mined.

The total zinc ore produced during the year amounted to 260,712 dry tons containing a total of 2,163 ounces of gold, 1,652,608 ounces of silver, 1,031,709 pounds of copper, 6,837,281 pounds of lead, and 66,465,833 pounds of zinc, or an average assay of 0.0083 ounce of gold, 6.34 ounces of silver, 0.19 per cent of copper, 1.31 per cent of lead, and 12.75 per cent of zinc. * * *

The production of copper ore amounted to 11,541 dry tons, containing a total of 54 ounces of gold, 76,975 ounces of silver, 833,393 pounds of copper, 59,506 pounds of lead, and 774,921 pounds of zinc, or an average assay of 0.0047 ounce of gold, 6.67 ounces of silver, 3.61 per cent of copper, 0.26 per cent of lead, and 3.36 per cent of zinc.

The Pittsmont mine of the East Butte Copper Mining Co., east of Butte, was worked the entire year and was a large producer of both silver and copper. The entire output (copper ore) was shipped to Anaconda for milling and smelting, as both the milling plant and the smelting plant at Pittsmont have been idle since August, 1924. The property is opened by three vertical shafts, the deepest of which is 2,640 feet, and development in 1928 consisted of 4,244 feet of drifts, crosscuts, and raises, and included deepening the 3-compartment shaft 205 feet. The ore, which is all sulphide, contains quartz, pyrite, enargite, and chalcocite. No dividends were distributed in 1928, but the company has paid \$1,676,370 in the past. From the Pittsmont property the company mined 110,997 dry tons of copper ore, averaging 4.41 per cent of copper and 4.04 ounces of silver to the ton. The metal content for which payment was made was reported as 1.20 ounces of gold, 389,860 ounces of silver, and 8,537,068 pounds of copper, but no statement was published giving the results after milling and smelting the ore at Anaconda. The company also shipped 41 tons of copper precipitates, averaging 62.53 per cent of copper, or 47,565 pounds for which payment was made. In 1928 the Pittsmont mine ranked second as a producer of copper and fifth as a producer of silver in Montana. The gross value of the ores shipped in 1928 was \$739,521, and the operating cost was \$685,005. The net profit on all operations was \$100,747. The company, which also owns property in Colorado and Nevada, gave the following paragraphs regarding the Pittsmont mine at Butte in its annual printed report for 1928:

The entire production of the Pittsmont Mine at Butte was sold to the Anaconda Copper Mining Co. under an agreement which will expire December 30, 1929.

* * * The net profits on operations at Butte, notwithstanding the drop in metal content and an increase in wages of 50 cents per day effective October 1, is traceable to the marked increase in tonnage mined, substantially lower development expenditure, and improved copper market. * * *

Expenditures attributable to exploration and development totaled \$99,891.56.

* * * Ground removed from station cutting and other work similar in character totaled 13,272 cubic feet.

The deeper development program undertaken last spring did not forge ahead as rapidly as anticipated due to unfavorable labor conditions which prevailed throughout the summer months. The No. 4 shaft, a standard 3-compartment shaft and the present working shaft, was deepened 205 feet, a station was established on the 2,600 level, the deepest level in the mine, and at the end of the year crosscutting north from the shaft had been advanced 368 feet. * * *

As to ore reserves, a careful survey recently completed forms the basis of an estimate of approximately 135,000 tons of marketable ores, under favorable metal prices, in Pittsmont mining ground and in leased territory, at the beginning of 1929.

The Elm Orlu Mining Co. operated its mine at Butte for seven months and shipped a large quantity of lead-zinc ore to the Timber Butte Milling Co.'s plant south of Butte; in August both the mine and the mill were purchased by the Anaconda Copper Mining Co., which operated the property the remainder of the year. Under the new management from August to December the mine produced 4,676 tons of copper ore and 87,406 tons of zinc ore, both of milling grade. The ore is separated into a lead concentrate, which is shipped to a lead smelter, and a zinc concentrate, which is treated in the electrolytic zinc plants at Great Falls and Anaconda. Part of the product was sulphide copper ore shipped to Anaconda to be milled. The

mine ranked second in the production of zinc in Montana, third in silver, fourth in lead, and fifth in copper. The property is extensively developed and is opened to a depth of 3,400 feet by a vertical shaft. The mine has been one of the largest producers of zinc in Montana since 1914, but no printed report giving details of operations has ever been issued by the Elm Orlu Mining Co.

The custom flotation mill at Timber Butte, south of Butte, was active throughout the year, even after it was sold to the Anaconda Copper Mining Co. in August. The ore supply came chiefly from the Elm Orlu, Poser, Otisco, and Ardsley Butte properties, but included much custom material from mines in various counties, especially in Silver Bow, Jefferson, Cascade, and Granite Counties. The plant treated nearly 365,000 tons of ore in 1928 and made two grades of concentrates—a high-grade silver-lead product for smelting and a high-grade zinc product for treatment by roasting and electrolysis.

The North Butte Mining Co., which owns the Granite Mountain, Speculator, and Bertha properties, was in the hands of a receiver and did no mining in 1928. In December, however, the company was reorganized, and the mine again became regularly productive in 1929.

The Poser mine was operated the entire year by the Elm Orlu Mining Co., which shipped nearly 96,000 tons of lead-zinc ore to the Timber Butte mill for treatment by flotation. Although the output was considerably less than that in 1927, the mine ranked third as a producer of lead, fourth as a producer of zinc, and seventh as a producer of silver in Montana in 1928.

The Otisco property, also operated by the Elm Orlu Mining Co., produced more than 32,000 tons of lead-zinc ore, which was treated at the Timber Butte mill. As a result of the marked increase in its output, the Otisco mine ranked sixth as a producer of zinc, eighth as a producer of lead, and thirteenth as a producer of silver in Montana in 1928. An interesting feature of the year was the development in the southwest section of the Butte area. The Agnes-Highland group of the Ardsley Butte Mines Corporation, 2 miles southwest of Butte, was operated throughout the year. The company shipped 16,700 tons of lead-zinc ore to the Timber Butte mill and several cars of first-class siliceous silver ore to Anaconda for smelting. Although the milling ore contains lead and zinc it is chiefly valuable for its silver content, and in 1928 the property ranked sixth as a producer of silver in Montana. The mine is opened by a vertical shaft 500 feet deep and by drifts on 3 levels; the company spent \$37,890 for development in 1928. The Goldstream mine of the Ardsley Butte Extension Mining Co., adjoining the Highland mine, produced more than 5,000 tons of lead-zinc ore chiefly valuable for its silver content. The ore contained galena, sphalerite, tetrahedrite, and chalcopyrite and was shipped to Butte for milling. In 1928 about 1,500 feet of development was done, chiefly in drifting, and the company made progress in sinking a 2-compartment shaft. The mine ranked twelfth as a producer of silver in Montana, although operations were started late in the year. Much work was done at other promising prospects southwest of Butte, such as the Butte Olive Branch, Butte Wisdom, Butte & Isele, Butte Independent, and Butte Southern.

The Magnolia property owned by the Anaconda Copper Mining Co. was worked by lessees, and 4,086 tons of silver-lead-zinc ore was shipped to the flotation plant of the Timber Butte Milling Co. The Eveline mine was operated by a lessee who shipped nearly 1,000 tons of lead-zinc ore to Butte for milling and 2 cars of first-class siliceous silver ore to Anaconda for smelting. The Badger State property of the Anaconda Copper Mining Co. was reopened and produced 1,637 tons of lead-zinc ore of milling grade. Other producers of lead-zinc ore were the Minnie Jane, Moulton, Lizzie, Goldsmith, Curry, Garfield-Salvador, Magna Charta, Elba, and Venus. The Moulton, Goldsmith, and Venus also produced first-class siliceous silver ore. The Right Bower mine of the Anaconda Copper Mining Co. was worked by a lessee who shipped about 1,300 tons of first-class oxidized copper ore to Anaconda for smelting. The Lizzie mine also produced a little first-class copper ore, and small lots of similar material came from the Butte-Bullwhacker, Rose O'Malley, and B & B properties. Small lots of first-class silver ore were shipped from the Little Darling, West Olive Branch, Alice, French Joe Fraction, I. X. L., and Unexpected Williamsburg claims. A small lot of slag containing a little copper was shipped from the old Bell smelter dump, and more than 1,500 tons of low-grade copper ore containing more than 6 ounces of silver to the ton was shipped from the East Butte dump to Anaconda for smelting.

LEAD¹

By ELMER W. PEHRSON²

GENERAL SUMMARY

Salient figures of the lead industry in the United States, 1927 and 1928

	1927	1928
Production of refined primary lead:		
From domestic ores.....short tons..	668,320	626,202
From foreign ores and base bullion.....do.....	128,210	154,869
	796,530	781,071
Recovery of secondary lead:		
As pig lead.....do.....	119,000	138,000
In alloys.....do.....	157,000	170,600
	276,000	308,600
Total production of pig lead (primary and secondary).....do.....	915,530	919,071
Imports (general):		
Lead in base bullion.....do.....	118,284	128,468
Lead in ore.....do.....	40,638	25,915
Exports:		
Refined pig lead from domestic ores.....do.....	2,533	14,202
Refined pig lead from foreign materials.....do.....	122,734	102,067
Apparent consumption of refined primary lead.....do.....	1662,973	657,565
Estimated consumption of primary and secondary lead.....do.....	840,950	920,500
Prices per pound of refined lead at New York:		
Highest monthly average.....cents.....	7.61	6.50
Lowest monthly average.....do.....	6.26	6.02
Average for year.....do.....	6.75	6.31
Quotation at end of year.....do.....	6.50	6.50
Mine production of recoverable lead.....short tons.....	665,489	2627,153
Southeastern Missouri district.....per cent of total.....	30	31
Utah.....do.....	23	23
Coeur d'Alene region.....do.....	21	22
Joplin (tri-State) region.....do.....	12	11
All other.....do.....	14	13
World smelter production of lead.....short tons.....	1,900,000	1,879,000
United States.....per cent of total.....	37	35
Mexico.....do.....	12	13
Australia.....do.....	10	9
Canada.....do.....	8	8
All other.....do.....	33	35

¹ Revised figures.

² Exclusive of the output from Virginia, figures for which the Bureau of Mines is not at liberty to publish.

The depression in the primary lead industry, which had continued steadily during the past few years, appeared to have reached an end in 1928, and a slight but definite upward trend was evident during the latter part of the year. Although the production of primary refined lead in the United States was 2 per cent less than that in 1927, the decline was due largely to curtailment during the first half of the year. The American Bureau of Metal Statistics reported the lowest

¹ Work on manuscript completed December, 1929.

² The statistics in this report were prepared (unless otherwise indicated) by H. M. Meyer, and the data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the Bureau of Mines.

monthly output as in July, after which there was a definite upward trend. Outstanding features in the production of refined primary lead in 1928 were the 6 per cent decrease from domestic ores and the 21 per cent increase from foreign materials. The latter was the net result of the 34 per cent increase in the refined lead produced from foreign base bullion and the 18 per cent decrease in the amount obtained from smelting foreign ore.

The downward trend in the price of lead, so apparent in 1927, continued during the first part of 1928, reaching the low point of the year early in March; during the remainder of the year the trend was definitely upward. The New York monthly average was 6.50 cents for January. The low average for the year was 6.02 cents for March. By October the average was again 6.50 cents. There was a slight recession in November, but the price again averaged 6.50 cents for December. The average for the year was 6.31 cents in 1928, as compared to 6.75 cents in 1927. Owing to the depressed London market in 1928 the New York price exceeded the St. Louis average by only 0.17 cent per pound, as compared to 0.23 cent in 1927. The New York price was 1.73 cents above the London average in 1928, as compared to 1.50 cents in 1927.

The recovery of secondary lead in pig lead and in alloys in 1928 broke all previous records; it amounted to 308,600 tons or the equivalent of 49 per cent of the primary lead produced from domestic ores. Secondary lead recovered as pig lead amounted to 138,000 tons or 45 per cent of the total secondary lead recovered in 1928.

The total consumption of lead in the United States, as estimated by the American Bureau of Metal Statistics, amounted to 930,500 tons in 1928, an increase of 11 per cent over 1927 and surpassing all previous records. Storage batteries ranked first among the consumers of lead in 1928 and showed a 26 per cent increase over 1927 in the quantity of lead used. Cable covering was next in importance and used 12 per cent more lead in 1928 than in 1927. White lead was the third largest consumer in 1928, but showed a slight decrease in the quantity of lead used. This industry, which consumed 23 per cent of the total lead used in 1922, took only 13 per cent of the total in 1928. Owing to the large increase in the recovery of secondary lead there was a decrease of 1 per cent in the apparent consumption of primary lead.

Mine production of lead in the United States showed a 6 per cent decrease in 1928, fairly general throughout the States—production in the Western States having been curtailed 6 per cent and that in the Mississippi Valley States, 5 per cent. Oklahoma suffered the largest tonnage cut, and Virginia was the only State in which there was a substantial increase.

General imports of lead in base bullion increased about 10,000 tons or 9 per cent, largely as a result of importations from Peru, where an American copper company began lead-smelting operations. Imports of lead in ore decreased nearly 15,000 tons, or 36 per cent, largely as a result of smaller shipments from Mexico. Exports of refined pig lead from domestic ores were nearly 12,000 tons (461 per cent) greater in 1928 than in 1927; at the same time exports of foreign pig lead decreased nearly 21,000 tons, or 17 per cent.

An important development in the United States lead industry in 1928 was the organization, on November 14, of the Lead Industries

Association, comprising both producers and consumers of lead. Its purposes are to promote service among lead industries to the community at large, disseminate accurate information regarding the use of lead products, collect statistics on marketing and consumption of lead and its products, and develop methods to improve the welfare of those in the lead industries. Its membership includes corporations engaged in mining, smelting, and manufacturing lead in the United States, Mexico, Canada, and South America. Early in 1929 the association began distributing weekly reports on the production, sales, and stocks of pig lead and white lead in the United States.

World smelter production of lead in 1928 amounted to 1,879,000 short tons, a decrease of about 1 per cent as compared with 1927. Production outside of the United States increased 2 per cent. Mexico's output, which ranked second to that of the United States, amounted to 13 per cent of the world total; it was 6 per cent greater than in 1927. Australia was third, with 9 per cent of the world total; it produced 6 per cent less than in 1927. Canada ranked fourth, with 8 per cent; it increased its output 2 per cent. Spain fell off 9 per cent but ranked fifth, with slightly less than 8 per cent of the world total. Germany and Belgium followed in order, with little change in production. India increased its output 19 per cent, and Peru and Poland also increased their production considerably.

The London price of lead in 1928 averaged £21.058 per long ton, or 4.58 cents per pound, a decrease from 1927 of 13 per cent as compared with a decrease of 7 per cent in the New York price. The low price prevailing in Europe caused European producers to consider curtailment of output along the lines of the Zinc Cartel. A meeting was held in London in September, 1928, but results were largely negative. Arrangements were made for collection of complete statistical data, but it was concluded that world stocks of lead were inconsiderable, that production was about keeping even with consumption, and that curtailment of output was unnecessary at that time. Later in the year it was announced that another meeting would be held in March, 1929.

During the past few years some important ore bodies containing large quantities of lead have been developed. The most important is the Mount Isa deposit in Queensland, Australia, which is reported to have ore reserves as follows: 3,500,000 tons of carbonate ore averaging 9 per cent lead and 3.6 ounces of silver per ton; 17,200,000 tons of sulphide ore containing 6.1 per cent lead, 8.2 per cent zinc, and 3.7 ounces of silver; and an additional 500,000 tons of sulphide ore of much higher grade. Production is expected in 1930, and the capacity of the plant is to be eventually 2,000 tons of ore per day. In Canada there was considerable development of lead-zinc properties, especially in British Columbia, from which an increased output is expected. The Buchans mine in Newfoundland is reported to have a reserve of 5,750,000 tons of ore averaging 7.65 per cent lead, 17.85 per cent zinc, 0.033 ounce of gold, 3.25 ounces of silver, and 1.4 per cent copper. Production at the rate of 300 tons of ore per day was begun in the latter part of the year, and an increase to 500 or possibly 1,000 tons was expected soon. In France, Russo-Asiatic Consolidated (Ltd.) has developed ore bodies at Villemagne and St. Sebastien which appear to have promising futures. No substantial discoveries of lead ore were reported in the United States in 1928.

PRODUCTION

GENERAL

Pig lead produced in the United States for domestic market and export is derived from three main sources—domestic ore, foreign ore and base bullion, and secondary materials. The following table shows the quantity of pig lead produced from each of these sources from 1919 to 1928.

Pig lead produced in the United States, 1919–1928, in short tons

Year	From domestic ores and base bullion	From foreign ores and base bullion	From secondary materials	Total
1919.....	424, 433	57, 787	55, 684	537, 904
1920.....	476, 849	52, 808	56, 350	586, 007
1921.....	398, 222	50, 367	46, 370	494, 959
1922.....	468, 746	63, 916	75, 480	608, 142
1923.....	543, 841	74, 481	96, 430	714, 752
1924.....	566, 407	124, 086	90, 400	780, 893
1925.....	654, 921	112, 048	112, 420	879, 389
1926.....	680, 685	118, 256	125, 000	923, 941
1927.....	668, 320	128, 210	119, 000	915, 530
1928.....	626, 202	154, 869	138, 000	919, 071

The total production of pig lead for domestic market and export in 1928 increased 3,541 tons, or less than one-half of 1 per cent. The production of pig lead from domestic ore and base bullion decreased 6 per cent, whereas that from foreign ore and base bullion and from secondary materials increased 21 and 16 per cent, respectively.

PRIMARY LEAD

REFINERY PRODUCTION

Pig lead is classified by the Bureau of Mines as primary or secondary, according to whether it is derived directly from the smelting of ores and from base bullion or is reclaimed from industrial lead scrap. Some plants that ordinarily smelt ore frequently add lead scrap to the charge, so that the resulting product is an inseparable mixture of lead from both sources and is all marketed as refined pig lead. Nevertheless, the smelter calculates the quantity of secondary lead so produced, thus enabling the Bureau of Mines to obtain a consecutive record of the amount of primary lead being supplied to the trade each year.

Primary lead may be produced from domestic ore or foreign ore and from base bullion. The smelting of lead-bearing ores from the Western States yields an impure pig lead (base bullion) that contains valuable amounts of silver and gold, in addition to objectionable impurities such as copper, arsenic, and antimony. This base bullion is given further treatment for the removal of the impurities and finally emerges for the market as refined pig lead. The smelting of lead-bearing ores from the Mississippi Valley and Southern States yields soft lead pure enough for marketing, but some of it is desilverized and is designated in this report as desilverized soft lead. Foreign ore is first smelted into base bullion and then refined for market. Foreign base bullion imported into the United States is also refined before marketing. All of these products for market are referred to as refined lead. The following table gives a summary of the refined primary lead produced in the United States from 1720 to 1928.

Refined primary lead produced in the United States, 1720-1928

Year	Short tons							Value	
	Desilverized lead ^{1 2}	Desilverized soft lead	Soft lead ²	Total production ¹	From domestic ores and base bullion	From foreign ores	From foreign base bullion	Average per pound	Total
1720-1912.....	7, 176, 497	326, 991	2, 929, 180	10, 432, 668	8, 545, 383	1, 887, 285			\$924, 600, 000
1913.....	301, 160	29, 433	131, 867	462, 460	411, 878	13, 223	37, 359	\$0. 044	40, 696, 000
1914.....	340, 397	43, 506	158, 219	542, 122	512, 794	7, 639	21, 689	. 039	42, 286, 000
1915.....	344, 593	44, 001	161, 461	550, 055	507, 026	9, 581	33, 448	. 047	51, 705, 000
1916.....	335, 375	68, 244	167, 515	571, 134	552, 228	6, 085	12, 821	. 069	78, 817, 000
1917.....	365, 998	56, 268	188, 503	610, 769	548, 450	15, 872	46, 447	. 086	105, 052, 000
1918.....	382, 314	47, 418	210, 463	640, 195	539, 905	15, 334	84, 956	. 071	90, 908, 000
1919.....	266, 538	67, 938	147, 744	482, 220	424, 433	7, 656	50, 131	. 053	51, 115, 000
1920.....	273, 135	66, 668	189, 854	529, 657	476, 849	8, 414	44, 394	. 080	84, 745, 000
1921.....	238, 329	52, 747	157, 513	448, 589	398, 222	7, 120	43, 247	. 045	40, 373, 000
1922.....	249, 107	74, 305	209, 250	532, 662	468, 746	13, 898	50, 018	. 055	58, 593, 000
1923.....	366, 241	61, 332	190, 749	618, 322	543, 841	24, 288	50, 193	. 070	86, 565, 000
1924.....	423, 429	63, 449	203, 615	690, 493	566, 407	46, 385	77, 701	. 080	110, 479, 000
1925.....	457, 477	48, 932	260, 560	766, 969	654, 921	47, 024	65, 024	. 087	133, 453, 000
1926.....	484, 669	55, 707	258, 565	798, 941	680, 685	48, 210	70, 046	. 080	127, 831, 000
1927.....	507, 099	55, 487	233, 944	796, 530	668, 320	32, 369	95, 841	. 063	100, 363, 000
1928.....	506, 603	49, 465	225, 003	781, 071	626, 202	26, 632	128, 237	. 058	90, 604, 000
	13, 018, 961	1, 211, 891	6, 024, 005	20, 254, 857	17, 126, 290	3, 128, 567			2, 218, 185, 000

¹The lead content of antimonial lead is excluded; see p. 615. ²Desilverized soft lead is excluded.

The total production of refined primary lead in the United States in 1928 was 1.9 per cent less than the 1927 output and was only 2.2 per cent less than the 1926 production, the maximum annual output to date. The greater relative decrease in total value was due to the marked decline in the average price of lead. The total value for 1928 was 10 per cent less than that for 1927 and 29 per cent less than that for 1926, and amounted to only 68 per cent of that for 1925, the peak annual value up to the end of 1928.

Two outstanding features in the production of primary lead in the United States in 1928 were the increased output from foreign sources and the decreased production from domestic ores. The production of lead from ore and base bullion of foreign origin amounted to 154,869 tons, an increase of 21 per cent over 1927. Foreign lead was 20 per cent of the total output in 1928, whereas it amounted to 16 per cent of the total in 1927. This increase was all due to the rising production of refined lead from foreign base bullion, which increased 34 per cent in 1928; refined lead derived from the smelting of foreign ores decreased 18 per cent in 1928. The production of refined lead from domestic ores in 1928 was 42,118 tons, or 6 per cent, less than that in 1927 and was lower than in any year since 1924. The total value of refined lead of domestic origin in 1928 was lower than in any year since 1922 and amounted to only 64 per cent of the peak value in 1925. The following table shows the quantity and value of refined lead produced in the United States from domestic ores from 1919 to 1928.

Refined lead produced in the United States from domestic ores, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	424, 433	\$44, 990, 000	1924.....	566, 407	\$90, 625, 000
1920.....	476, 849	76, 296, 000	1925.....	654, 921	113, 956, 000
1921.....	398, 222	35, 840, 000	1926.....	680, 685	108, 910, 000
1922.....	468, 746	51, 562, 000	1927.....	668, 320	84, 208, 000
1923.....	543, 841	76, 138, 000	1928.....	626, 202	72, 639, 000

GEOGRAPHICAL SOURCE OF LEAD RAW MATERIALS SMELTED OR
REFINED IN THE UNITED STATES

The following table shows the source of the ore and foreign base bullion from which refined lead was produced in the United States from 1919 to 1928. Most of the base bullion produced in the Western States is shipped to the Mississippi Valley and Eastern States for refining. In reporting the production of lead by sources most of the refiners make the distribution on the basis of base bullion, so that the total lead given in this table as from domestic ore includes both base bullion and refined lead and thus contains a large part of the antimonial lead produced from domestic ores. The total here given for 1928 exceeds the total production of refined lead from domestic ores, as shown on page 611, by 16,495 tons. The production of antimonial lead from domestic ores in 1928 amounted to 17,930 tons.

Primary lead smelted or refined in the United States, 1919-1928, by sources, in short tons

Source of ore	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Domestic ore:										
Alaska.....	645	591	773	324	400	582	699	1,018	1,010	962
Arizona.....	5,407	5,987	3,313	7,218	8,828	9,372	10,281	10,646	7,918	8,144
California.....	2,004	2,260	614	3,018	5,168	2,305	4,148	4,044	1,232	637
Colorado.....	18,867	17,752	12,104	11,108	23,885	25,491	31,855	37,553	37,040	28,683
Idaho.....	89,091	117,191	99,707	91,487	127,797	123,709	123,363	132,564	150,618	141,748
Illinois ¹	977	948	271	750	1,286	1,089	474	357	222	398
Kansas ¹	7,951	8,421	10,939	10,900	20,207	12,895	15,001	20,884	27,530	20,889
Kentucky ¹	83	114	41	73	66	201	96	27	139	268
Missouri ¹	150,341	171,999	151,028	202,245	169,323	191,501	208,547	218,083	210,366	192,789
Montana.....	17,513	13,231	11,565	14,551	18,345	21,226	22,008	26,350	23,041	20,470
Nevada.....	5,958	8,650	3,553	4,264	8,044	8,070	10,978	11,379	8,680	6,823
New Hampshire.....	16									
New Mexico.....	1,418	1,123	384	1,230	1,638	2,263	3,782	4,383	8,377	8,469
Oklahoma ¹	49,984	68,494	46,902	67,436	59,602	56,017	78,487	70,004	265,790	52,817
Oregon.....				37	47		6	5	2	7
South Dakota.....	18	6	2	2		2	2	1	79	37
Tennessee ¹	2,371	2,705		751	1,020	985	436	770	19	
Texas.....	8	1	1	5	40	27	31	102	275	437
Utah.....	65,102	64,006	51,872	63,130	104,678	119,318	166,844	151,127	155,199	151,724
Virginia ¹					1,582	2,179	1,714		2,214	4,944
Washington.....	1,090	2,460	325	478	2,008	2,057	2,802	2,262	442	537
Wisconsin ¹	3,975	3,841	1,079	1,323	601	1,973	2,889	2,052	2,067	1,812
Undistributed.....	119	201	101	75	691	15	2			
Zinc residues.....	4,887	4,366	713	1,284	362	1,320	1,541	505	1,905	102
	427,825	494,347	305,287	481,689	554,036	582,000	686,451	695,830	684,165	642,697
Foreign ore:										
Africa.....	644	1,171			99	6		6	12	2
Australia.....	69	450								
Canada.....	1,895	1,186	2,877	3,604	3,632	4,633	10,676	5,385	4,138	10,123
Central America.....	12	22	6	14	18	30	6		18	3
Europe.....	122	19	17	519	139	328	470	233	19	67
Mexico.....	2,261	2,729	1,912	7,260	18,867	33,328	31,107	32,693	22,844	14,839
South America.....	2,537	2,747	2,235	2,458	1,461	7,663	4,496	9,893	5,506	1,568
Other foreign.....	116	90	73	43	72	397	269			30
Foreign base bullion:										
Canada.....	567	1,919	1,599	2,900						
Mexico.....	49,564	42,421	41,648	47,118	50,193	77,701	65,024	70,046	95,841	117,193
South America.....		54								11,044
	57,787	52,808	50,367	63,916	74,481	124,086	112,048	118,256	128,380	154,869
Grand total.....	485,612	547,155	445,654	545,605	628,517	706,086	798,499	814,086	812,545	797,566

¹ The lead produced by these States is nonargentiferous or soft lead. A small quantity of the lead produced from Colorado and New Mexico ores is also nonargentiferous.

² Mine production figures for Kansas are 27,497 short tons and for Oklahoma, 51,680 tons. In view of the great discrepancy between mine and smelter figures for these States, it is reasonable to assume that some Kansas ore was shipped to the smelters from Oklahoma points.

Fifty-seven per cent of the lead produced in 1928 from domestic ores was from Western States ore, and nearly 43 per cent was from ore mined in the Central and Eastern States. Small amounts were derived from Alaska ore and from residues from zinc smelters. Decreased production was the general rule in the important States. Virginia showed the greatest increase; Arizona and New Mexico made slight increases.

Refined lead produced from foreign ore amounted to 26,632 tons; Mexican ores supplied 56 per cent of it, Canadian ores 38 per cent, and South American ores nearly 6 per cent. Lead smelted from Mexican ore decreased 35 per cent in 1928 and that from South American ore decreased 72 per cent, while that from Canadian ore increased 145 per cent.

Mexico supplied 91 per cent and South America 9 per cent of the foreign base bullion refined in the United States in 1928. Refined lead from Mexican base bullion increased 22 per cent. The production from South American base bullion was the first reported in several years; all of it came from Peru, where an American copper company began large-scale lead-smelting operations.

SPECIFICATIONS FOR PIG LEAD

The American Society for Testing Materials classifies pig lead in three grades—corroding, chemical, and common. The requirements as to chemical composition are shown in the following table.

Allowable chemical composition of the various grades of pig lead, as specified by the American Society for Testing Materials

	Corroding lead, ¹ not over—	Chemical lead ²	Common lead	
			Desilverized lead, not over—	Soft Missouri lead, not over—
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Silver.....	0.0015	0.005-0.015	0.002	0.002
Copper.....	.0015	.04- .08	.0025	.040
Copper and silver together.....	.0025	(³)	(³)	(³)
Arsenic.....	.0015	(³)	.015	.015
Antimony and tin together.....	.0095	(³)		
Zinc.....	.0015	(³)	.002	.002
Iron.....	.002	(³)	.002	.005
Bismuth.....	.05	(⁴)	.25	.005
Lead, by difference.....	99.9300	(⁵)	99.7265	99.931

¹ The maximum limits for bismuth, copper, and silver have been given, but it is not expected that any delivery will contain the maximum of all three.

² Chemical lead is a designation that has been used for many years in the trade to describe the undersilverized lead produced from Southeastern Missouri ores.

³ Not given.

⁴ Less than 0.005 per cent.

⁵ Not specified.

SOFT LEAD

A large part (44 per cent in 1928) of the lead produced in the United States from domestic ores is derived from the nonargentiferous lead ores of the Mississippi River Basin. The two principal ore-producing areas are the Southeastern Missouri district and the tri-State district (Joplin) at the junction of Missouri, Kansas, and Oklahoma. The former district produced about 71 per cent and the latter 26 per cent of the total soft lead in ore mined in 1928.

Eighty-two per cent of the soft pig lead produced in 1928 was marketed without desilverizing, and 18 per cent was desilverized. The former, which is known in the trade as chemical lead, contains 1 to 4 ounces of silver to the ton and 0.04 to 0.08 per cent copper; it is used chiefly in the manufacture of cable, pipe, and sheets. Desilverized soft lead is used largely in the manufacture of white lead, where a very pure product is required.

A substantial quantity of high-grade lead concentrates from the Mississippi Valley is used each year in the manufacture of lead pigments, principally basic lead sulphate (white sublimed lead) and leaded zinc oxide. In 1928 more than 10,000 tons of soft lead was recovered in this manner.

The following table summarizes the production of soft lead from 1922 to 1928.

Soft lead produced in the United States from domestic ores, 1922-1928, in short tons

Year	Soft pig lead			Soft lead re-covered in pigments	Total soft lead	Total domestic lead ¹	Soft lead percentage of domestic lead
	Undesilverized	Desilverized	Total				
1922.....	209,250	74,305	283,555	13,892	297,447	488,448	61
1923.....	190,749	61,332	252,081	13,612	265,693	567,247	47
1924.....	203,615	63,449	267,064	15,338	282,402	593,486	48
1925.....	260,560	48,932	309,492	17,547	327,039	684,968	48
1926.....	258,565	55,707	314,272	13,685	327,957	710,990	46
1927.....	233,944	55,487	289,431	13,136	302,567	695,500	44
1928.....	225,003	49,465	274,468	10,465	284,933	652,492	44

¹ Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in pigments.

ANTIMONIAL LEAD

Antimonial lead is an important by-product of the refining of base bullion. In 1928, 33,058 tons of primary antimonial lead was produced, which contained 29,626 tons of lead, an increase of 36 per cent over the 1927 output of antimonial lead and equivalent to 6.5 per cent of the total refined lead produced from base bullion. The principal uses of antimonial lead are in the manufacture of storage batteries, bearing metal, and type metal. The consumption of antimonial lead in storage batteries increased nearly 40 per cent in 1928. The following table shows the production of primary antimonial lead from 1919 to 1928.

By-product primary antimonial lead produced in the United States, 1919-1928

Year	Total lead refined from base bullion (short tons)	By-product antimonial lead (percent-age of total)	Antimonial lead						
			From domestic ore (short tons)	From foreign ore (short tons)	Short tons	Value	Total		
							Antimony content		Lead content by difference (short tons)
							Short tons	Percent-age	
1919	266,538	5.2	9,674	4,200	13,874	\$1,513,968	1,943	14.0	11,931
1920	273,135	4.6	9,604	2,931	12,535	1,963,255	2,033	16.2	10,502
1921	238,329	4.2	7,881	2,183	10,064	870,039	1,589	15.8	8,475
1922	249,107	3.2	7,068	1,007	8,075	844,993	1,441	17.8	6,634
1923	366,241	3.9	11,635	2,555	14,190	1,950,370	2,170	15.3	12,020
1924	423,429	4.9	13,593	7,194	20,787	3,376,713	2,763	13.3	18,024
1925	457,477	4.3	14,472	5,195	19,667	3,785,547	2,624	13.3	17,043
1926	484,669	4.6	18,909	3,615	22,524	3,916,714	2,693	12.0	19,831
1927	507,099	4.8	16,040	8,307	24,347	3,277,043	2,736	11.2	21,611
1928	506,603	6.5	17,930	15,128	33,058	3,978,318	3,432	10.4	29,626
Average.....		4.7						13.1	

SECONDARY LEAD

Much of the lead consumed in the United States is used in the manufacture of articles from which there is a large return of secondary metal. This is particularly true of the storage-battery industry, which is the leading single consumer of lead and in which there is a large and rapid return of secondary metal. This industry is responsible for much of the increase in the ratio of secondary lead production to domestic primary lead production. In 1914 the secondary output was equivalent to only 12 per cent of the primary output from domestic ores; in 1928 the ratio was 49 per cent, an increase from 41 per cent in 1927 and the record to date. Other important lead-consuming industries in which there is a large return of secondary metal include cable manufacture, building, bearing metal, and type metal.

Fifty-five per cent of the secondary lead output in 1928 was recovered in the form of alloys, principally alloys of lead, tin, and antimony, and 45 per cent was recovered as pig lead.

The following tables show the recovery of secondary lead and its ratio to the refined primary lead produced in the United States from domestic ores. Further details of the secondary lead industry may be found in the Mineral Resources chapter on secondary metals.

Secondary lead recovered in the United States, 1922-1928, in short tons

Year	Pig lead	Lead in alloys	Total recovered lead	Value
1922	75,480	84,080	159,560	\$17,552,000
1923	96,430	98,060	194,490	27,229,000
1924	90,400	114,100	204,500	32,720,000
1925	112,420	114,460	226,880	39,477,000
1926	125,000	152,300	277,300	44,368,000
1927	119,000	157,000	276,000	34,776,000
1928	138,000	170,600	308,600	35,798,000

Ratio of secondary lead recovered to refined primary lead produced in the United States from domestic ores, 1913-1928

Year	Refined primary lead		Secondary lead	
	Short tons	Average price per pound (cents)	Short tons	Ratio to refined primary lead (per cent)
1913.....	411, 878	4. 4	72, 834	18
1914.....	512, 794	3. 9	61, 062	12
1915.....	507, 026	4. 7	78, 900	16
1916.....	552, 228	6. 9	96, 300	17
1917.....	548, 450	8. 6	93, 500	17
1918.....	539, 905	7. 1	97, 100	18
1919.....	424, 433	5. 3	122, 100	29
1920.....	476, 849	8. 0	124, 650	26
1921.....	398, 222	4. 5	103, 780	26
1922.....	468, 746	5. 5	159, 560	34
1923.....	543, 841	7. 0	194, 490	36
1924.....	566, 407	8. 0	204, 500	36
1925.....	654, 921	8. 7	226, 880	35
1926.....	680, 685	8. 0	277, 300	41
1927.....	668, 320	6. 3	276, 000	41
1928.....	626, 202	5. 8	308, 600	49

PIGMENTS

Lead pigments manufactured in 1928 contained 254,000 tons of lead derived from the sources shown in the following table. Refined pig lead is used in the manufacture of white lead, litharge, red lead, sublimed lead, and orange mineral, and in 1928 about 243,000 tons of the lead contained in lead pigments was derived from refined pig lead; white lead accounted for 52 per cent of it, litharge 32 per cent, red lead 14 per cent, and sublimed lead and orange mineral 2 per cent. Sublimed lead and leaded zinc oxide are the principal pigments in which the lead content is derived from ores.

Further details of the production and value of lead pigments in the United States are given in the Mineral Resources chapter on lead and zinc pigments and salts.

Lead in pigments,¹ 1922-1928, by sources, in short tons

Year	Lead in pigments from—			
	Domestic ore	Foreign ore	Metal	Scrap
1922.....	13, 892	-----	241, 096	111
1923.....	13, 612	-----	236, 541	-----
1924.....	15, 338	545	250, 930	-----
1925.....	17, 547	-----	256, 064	-----
1926.....	13, 685	-----	240, 902	1, 029
1927.....	13, 136	-----	242, 713	1, 246
1928.....	10, 465	-----	242, 914	654

¹Includes also lead recovered in zinc oxide and leaded zinc oxide.

MINE PRODUCTION

BY STATES

The Bureau of Mines canvasses every mine yielding lead in order to ascertain the quantity and metal content of the ores produced. Allowance is made for metallurgical losses, and the estimates of re-

coverable lead are combined into State totals. Such totals for the 10-year period 1919 to 1928 are given in the following table. The bureau is not at liberty to publish the total for Virginia in 1928, as it would disclose confidential information, so the output of that State is excluded from the United States total.

Mine production of recoverable lead, 1919-1928, by States, in short tons

State	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Alaska	687	875	759	377	410	631	789	778	1,008	1,019
Arizona	4,847	6,935	3,271	7,535	8,146	9,321	11,938	11,629	9,933	7,190
Arkansas	27	8	21	42	25	20	58	18	23	38
California	1,695	2,407	562	3,156	4,775	2,382	3,283	4,047	1,359	946
Colorado	18,535	23,315	9,830	11,739	22,849	23,779	31,483	34,494	33,386	26,751
Georgia		2		4						
Idaho	86,612	118,565	99,235	97,917	121,178	124,475	126,521	136,490	151,019	145,323
Illinois	2,063	1,708	672	1,325	1,381	1,464	1,001	655	277	385
Kansas	11,057	16,452	18,679	23,271	17,598	18,560	22,775	28,463	27,497	25,276
Kentucky	84	120	69	92	53	175	152	58	139	39
Maine	1									
Massachusetts		14				(¹)				
Missouri	160,024	161,812	180,085	178,412	169,743	189,929	211,566	207,012	198,760	195,393
Montana	16,358	14,846	10,183	14,884	17,973	19,738	18,765	21,153	17,949	16,880
Nevada	7,291	10,100	3,594	4,695	9,078	10,030	12,238	11,184	7,892	7,874
New Mexico	1,443	1,435	339	1,506	1,916	1,817	3,210	3,480	8,026	7,805
Oklahoma	52,795	64,086	41,552	62,856	66,904	71,358	79,946	69,704	51,680	43,687
Oregon				38	14	(²)	3	6	3	7
Pennsylvania		7								
South Dakota	16	6	2						69	37
Tennessee	2,079	1,880		732	1,250	937	448	800		
Texas	7			4	13		8	42	244	348
Utah	58,819	66,898	44,594	67,666	101,724	116,955	153,335	147,635	151,285	145,915
Virginia						1,275	2,229	2,450	2,393	(³)
Washington	1,019	2,749	72	691	1,453	1,968	2,814	2,273	478	542
Wisconsin	4,130	2,594	972	691	734	1,254	1,877	1,546	2,069	1,698
	429,589	496,814	414,491	477,633	547,217	596,068	684,439	683,917	665,489	627,153

¹ It is said that a few tons of lead ore was mined at the old Chipman mine in Massachusetts and was treated at a small smelter owned by the mine operators.

² 513 pounds.

³ Bureau of Mines not at liberty to publish figures.

⁴ Exclusive of the output from Virginia, figures for which the Bureau of Mines is not at liberty to publish

The foregoing table shows a total production of 627,000 tons of recoverable lead in 1928, a decrease of 6 per cent from 1927. Missouri produced nearly 32 per cent of the total and Utah and Idaho 23 per cent each, a total of 78 per cent for the three States. Oklahoma ranked fourth in production with 7 per cent, and was followed by Colorado and Kansas with about 4 per cent each, Montana with 3 per cent, and Nevada, New Mexico, and Arizona with about 1 per cent each. The combined output of all other States whose production is shown in the table amounted to less than 1 per cent of the total.

Curtailment of production was fairly general throughout the States. The three largest producers, Missouri, Utah, and Idaho, decreased 2, 4, and 4 per cent, respectively. Oklahoma suffered the largest tonnage cut, its output having been reduced 8,000 tons, or 15 per cent. Colorado's output was reduced 6,600 tons, or 20 per cent, and Arizona's 2,700 tons, or 28 per cent. The production of Virginia was larger in 1928 than in 1927.

Additional details of mine production of lead may be found in the chapters of Mineral Resources covering the mine production of gold, silver, copper, lead, and zinc in the various States or groups of States.

BY DISTRICTS

Mine production of recoverable lead in the principal lead-producing districts of the United States, 1921-1928, in short tons

District	State	1921	1922	1923	1924	1925	1926	1927	1928
Southeastern Missouri region.	Missouri	178, 735	176, 768	167, 458	187, 737	208, 915	203, 062	196, 251	194, 270
Coeur d'Alene region.	Idaho	94, 543	91, 216	114, 426	118, 327	120, 856	128, 834	141, 948	139, 276
Joplin region.	Kansas, Missouri, Oklahoma.	61, 581	87, 771	86, 787	92, 110	105, 372	102, 117	81, 686	70, 086
Bingham.	Utah	12, 288	19, 348	25, 353	34, 786	54, 982	54, 997	55, 508	52, 375
Tintic.	do.	18, 158	23, 646	38, 906	40, 674	45, 889	47, 108	45, 045	44, 096
Park City region.	do.	8, 846	16, 129	26, 220	33, 346	40, 656	35, 910	41, 403	41, 427
San Juan Mountains.	Colorado	5, 323	5, 332	13, 157	13, 148	17, 092	19, 237	21, 739	18, 555
Butte.	Montana	6, 614	10, 070	12, 745	13, 648	12, 091	13, 678	12, 769	12, 330
Rush Valley.	Utah	607	586	1, 284	926	2, 465	5, 022	7, 346	7, 222
Willow Creek.	New Mexico							4, 353	5, 193
Leadville.	Colorado	1, 762	2, 742	2, 804	4, 795	6, 931	9, 266	6, 781	5, 168
Bisbee (Warren).	Arizona	2, 335	4, 187	4, 221	5, 719	6, 657	5, 729	5, 256	2, 917
Jack Rabbit.	Nevada	866	791	536	120	224	578	1, 266	2, 561
Upper Mississippi Valley.	Iowa, Northern Illinois, Wisconsin.	1, 506	1, 259	948	1, 639	2, 355	1, 819	2, 141	1, 706
Montana.	Montana	749	775	912	1, 241	1, 427	2, 069	1, 866	1, 432
Warm Springs.	Idaho	2, 374	1, 758	925	357	355	149	478	1, 307
Vulture.	Arizona		3		4	26	133	133	1, 291
Texas.	Idaho	971	2, 168	2, 417	2, 197	1, 714	2, 882	3, 895	1, 195
Central.	New Mexico	2	176	656	592	1, 182	1, 306	954	1, 180
Pioche.	Nevada	666	932	2, 697	2, 152	2, 806	2, 420	639	1, 167
Yellow Pine.	do.	93	158	736	3, 855	2, 644	952	826	1, 105
Dome.	Idaho	24			276	602	246	1, 182	1, 074
Inyo County.	California	523	3, 135	4, 744	2, 306	3, 098	3, 278	1, 081	872
Aspen.	Colorado	1, 198	1, 778	1, 486	455	1, 820	1, 632	1, 203	806
Summit County.	do.	252	280	1, 946	1, 105	1, 707	1, 481	614	786
Eagle County.	do.	6	161	230	1, 145	2, 041	1, 305	2, 059	750
Pend d'Oreille.	Idaho	1	238	304	67	113	481	1, 048	694
Spruce Mountain.	Nevada	458	237	261	508	647	1, 099	636	529
Northport.	Washington	50	534	1, 062	1, 232	2, 218	1, 984	325	503
Magdalena.	New Mexico	30	462	753	818	1, 217	700	819	496
Banner.	Arizona	10	2, 140	1, 731	160	49	7	13	490
Eureka.	Nevada	388	251	673	888	2, 163	2, 784	1, 132	466
Kentucky-Southern Illinois.	Kentucky-Illinois	207	849	1, 220	1, 254	675	440	344	416
Port Hill.	Idaho	750	1, 440	2, 116	2, 317	1, 506	1, 597	468	414
Barker.	Montana	856	971	846	1, 272	1, 420	1, 387	412	264
San Francisco.	Utah	442	1, 118	1, 489	1, 069	1, 999	1, 325	420	199
Bryant.	Montana	83	158	968	1, 743	1, 150	730	398	195
Big and Little Cottonwood.	Utah	2, 230	2, 754	3, 831	3, 128	2, 374	1, 597	1, 009	146
Ophir.	do.	480	2, 921	3, 443	1, 414	2, 945	217	157	101
New Placers.	New Mexico				3	125	527	1, 100	48
Troy.	Montana	377	1, 528	1, 059	530	259	231	181	33
Mammoth.	Nevada	3	5	2	21	331	365	1, 195	21
Bell.	do.		612	1, 160		128	455	143	-----
Embree.	Tennessee		732	1, 250	937	448	800	-----	-----
Austinville ¹ .	Virginia				1, 275	782	1, 582	2, 398	(²)
Boulder ¹ .	Idaho				(²)	(²)	(²)	(²)	(²)

¹ Not listed according to rank.

² Bureau of Mines not at liberty to publish figures.

The foregoing table shows all of the mining districts that have produced 1,000 tons of lead, or more, in any of the 8 years from 1921 to 1928. The Southeastern Missouri district has been the largest producer for many years and in 1928 contributed 31 per cent of the United States total. The Coeur d'Alene region of Idaho ranked second in 1928, with 22 per cent of the total to its credit. The Joplin region (tri-State) at the junction of Missouri, Kansas, and Oklahoma ranked third, with 11 per cent of the total. The Bingham, Tintic, and Park City districts, all in Utah, ranked fourth, fifth, and sixth in 1928, having produced 8, 7, and 6.6 per cent, respectively, of the United States total. The San Juan Mountain district, Colorado, con-

tributed 3 per cent, and Butte district, Montana, 2 per cent. The Rush Valley district, Utah, was the only other district that produced more than 1 per cent of the total in 1928.

LEAD BALANCE SHEET OF THE UNITED STATES

Most of the lead ore mined in the United States is smelted, and its lead content emerges in marketable form as primary refined pig lead and antimonial lead. Some of the ore is used in the manufacture of pigments and some may be exported, but for several years the amount exported has been negligible. The total primary domestic lead in the various products in which it is produced for market is compared in the following table with the estimates of recoverable lead in the ore mined. The table begins with 1907, the first year for which the mine production of the entire country was determined. As the quantities compared were determined by independent canvasses of the producers and consumers of lead-bearing ore, the table gives a check on the accuracy of the figures.

Comparison of mine production of lead and primary domestic lead accounted for in lead products manufactured in the United States, 1907-1928, in short tons

Year	Mine production	Primary lead accounted for in—				Primary excess (+) or mine excess (—)
		Refined lead	Antimonial lead	Pigments made from ore	Total	
1907-1918	5, 653, 706	5, 249, 081	124, 168	121, 756	15, 503, 330	-150, 376
1919	429, 589	424, 433	8, 339	11, 179	2443, 954	+14, 305
1920	496, 814	476, 849	8, 032	15, 212	500, 093	+3, 279
1921	414, 491	398, 222	6, 675	9, 989	414, 886	+395
1922	477, 633	468, 746	5, 810	13, 892	488, 448	+10, 815
1923	547, 217	543, 841	9, 794	13, 612	567, 247	+20, 030
1924	596, 068	566, 407	11, 741	15, 338	593, 486	-2, 582
1925	684, 439	654, 921	12, 500	17, 547	684, 968	+529
1926	683, 917	680, 685	16, 620	13, 685	710, 990	+27, 073
1927	665, 489	668, 320	14, 044	13, 136	695, 500	+30, 011
1928	2 627, 153	626, 202	15, 825	10, 465	652, 492	+25, 339
1919-1928	5, 622, 810	5, 508, 626	109, 380	134, 055	5, 752, 061	+129, 254
1907-1928	11, 276, 516	10, 757, 707	233, 548	255, 811	11, 255, 394	-21, 122

¹ Includes 8,325 tons of lead produced from domestic ores smelted outside the country.

² Includes 3 tons of lead produced from domestic ores smelted outside the country.

³ Exclusive of the output from Virginia, figures for which the Bureau of Mines is not at liberty to publish.

The table shows substantial discrepancies for individual years, probably due largely to variations in mine and smelter stocks of ore, but in none of the last 10 years has the discrepancy exceeded 5 per cent of the total lead produced. From 1907 to 1918—12 years—mine production exceeded the primary lead accounted for in lead products by 150,000 tons, or less than 3 per cent. From 1919 to 1928 there was an excess of 129,000 tons, or 2 per cent, in favor of the lead contained in the lead products. For the total period of 22 years, 1907 to 1928, mine production exceeded the primary lead content of lead products by only 21,000 tons or less than one-fifth of 1 per cent.

LEAD SMELTERS AND REFINERIES

A list of lead smelters and refineries in the United States, Canada, and Mexico follows.

UNITED STATES

- Arizona: Douglas—Phelps Dodge Corporation. (Smelter.)
 California: Selby—Selby plant, American Smelting & Refining Co. (Smelter and refinery.)
 Colorado:
 Durango—Durango plant, American Smelting & Refining Co. (Smelter.)
 Leadville—Arkansas Valley plant, American Smelting & Refining Co. (Smelter.)
 Idaho: Kellogg—Bunker Hill & Sullivan smelter. (Smelter and refinery.)
 Illinois:
 Chicago—Federated Metals Corporation.³ (Smelter.)
 Collinsville—St. Louis Smelting & Refining Works of National Lead Co. (Smelter and refinery.)
 Federal—Federal plant, American Smelting & Refining Co. (Smelter.)
 Indiana:
 East Chicago—International Lead Refining Co.⁴ (Refinery only.)
 East Chicago—U. S. S. Lead Refinery (Inc.).⁵ (Refinery only. Betts electrolytic process.)
 Kansas: Galena—Galena plant, Eagle-Picher Lead Co. (Smelter.)
 Missouri:
 Granby—American Zinc, Lead & Smelting Co.⁶ (Smelter.)
 Herculaneum—St. Joseph Lead Co. (Smelter and refinery.)
 Joplin—Eagle-Picher Lead Co. (Smelter.)
 Montana: East Helena—East Helena plant, American Smelting & Refining Co. (Smelter.)
 Nebraska: Omaha—Omaha plant, American Smelting & Refining Co. (Smelter and refinery.)
 New Jersey:
 Newark—Balbach plant, U. S. Metals Refining Co. (Smelter and refinery.)
 Perth Amboy—Perth Amboy plant, American Smelting & Refining Co. (Smelter and refinery.)
 Oklahoma: St Louis—Ontario smelter, Eagle-Picher Lead Co. (Smelter.)
 Pennsylvania: Carnegie—Pennsylvania Smelting Co.⁶ (Smelter and refinery.)
 Texas: El Paso—El Paso plant, American Smelting & Refining Co. (Smelter.)
 Utah:
 International—International Smelting Co.⁴ (Smelter.)
 Midvale—United States Smelting, Refining & Mining Co. (Smelter.)
 Murray—Murray plant, American Smelting & Refining Co. (Smelter.)

CANADA

- British Columbia: Trail—Consolidated Mining & Smelting Co. of Canada (Ltd.). (Smelter and refinery. Betts electrolytic process.)
 Ontario: Galetta—Kingdon Mining, Smelting & Manufacturing Co. (Ltd.). (Smelter.)

MEXICO

- Chihuahua: Chihuahua—American Smelting & Refining Co. (Smelter.)
 Coahuila: Torreon—American Metal Co. (Ltd.). (Cia. Metalúrgica de Torreon.) (Smelter.)
 Hidalgo: Zimapan—Cia. Min. y Fundidora de Zimapan. (Smelter.)
 Nuevo Leon:
 Monterrey—American Metal Co. (Ltd.). (Cia. Minera de Peñoles—S. A.) (Smelter and refinery.)
 Monterrey—American Smelting & Refining Co. (Smelter and refinery.)

³ Smelters of secondary materials but treating some lead ores.

⁴ Subsidiary of Anaconda Copper Mining Co.

⁵ Subsidiary of the United States Smelting, Refining & Mining Co.

⁶ Plant idle in 1923.

San Luis Potosi: San Luis Potosi—American Smelting & Refining Co. (Cia. Minera Asarco.) (Smelter.)
 Zacatecas: La Fé—American Metal Co. (Ltd.). (Cia. Minera de Peñoles—S. A.) (Smelter.)

In the following paragraphs the production by the important lead-smelting companies, for which published data are available, is summarized.

The American Smelting & Refining Co. is the largest lead producer in the United States and operates several lead smelters and refineries in various parts of the United States and Mexico. It also has other extensive mining operations in North and South America. The following table shows the principal metal products from the company's operations during 1927 and 1928 in all countries.

Metals produced by the American Smelting & Refining Co., 1927 and 1928

	1927	1928
Gold.....ounces.....	1, 479, 899	1, 407, 286
Silver.....do.....	80, 671, 759	81, 434, 214
Lead.....pounds.....	953, 976, 000	943, 760, 000
Zinc.....do.....	104, 340, 000	94, 866, 000
Copper.....do.....	1, 073, 660, 000	1, 127, 426, 000

An important domestic subsidiary of the American Smelting & Refining Co. is the Federal Mining & Smelting Co., which operates mines in the Coeur d'Alene and tri-State (Joplin) districts; it is strictly a mining organization, its products being smelted in other plants of the American Smelting & Refining Co. The following table shows its production in 1927 and 1928, and the total from 1904 to 1928.

Metals produced by the Federal Mining & Smelting Co., 1927, 1928, and 1904-1928

	1927	1928	1904-1928
Ore.....short tons.....	1, 187, 060	958, 600	19, 248, 434
Gold.....ounces.....	57, 738	72, 389	3, 805, 222
Silver.....do.....	2, 187, 190	2, 010, 572	51, 626, 176
Lead.....short tons.....	45, 629	44, 022	1, 001, 482
Zinc.....do.....	44, 310	42, 669	303, 971

The Bunker Hill & Sullivan Mining & Concentrating Co. operates mines and a lead smelter in the Coeur d'Alene district and is the largest producer in that district. The metal production (mine output) in 1927 and 1928 was as follows:

	1927	1928
Ore mined and milled.....short tons.....	456, 134	452, 345
Silver.....ounces.....	1, 799, 891	1, 769, 528
Lead.....pounds.....	94, 971, 072	91, 241, 389
Zinc.....do.....		6, 008, 794

The company also does custom smelting but does not publish data on that phase of its operations.

The St. Joseph Lead Co. is the largest operator in the Southeastern Missouri lead district. The company's mine production in this district in 1927 and 1928 was as follows:

	1927	1928
Ore.....short tons..	4, 527, 695	4, 382, 138
Lead concentrates.....do.....	208, 381	202, 801
Lead content.....do.....	151, 045	147, 591
Zinc concentrates.....do.....	8, 390	6, 584

The company smelts part of its ore and ships the balance to custom smelters in the St. Louis district; it also has interests, the chief product of which is zinc, in other parts of the country.

The International Smelting Co., a subsidiary of the Anaconda Copper Mining Co., operates a custom smelter at Tooele, Utah, the production of which in 1927 and 1928 was as follows:

	1927	1928
Lead.....pounds..	146, 073, 315	145, 613, 624
Silver.....ounces..	8, 001, 707	8, 439, 372
Gold.....do.....	56, 850	65, 117
Copper.....pounds..	20, 119, 391	20, 654, 286

The product of the Tooele smelter is base bullion, which is refined by another subsidiary of the Anaconda company, the International Lead Refining Co., at East Chicago, Ind.

Important smelting companies, which do not publish production statistics, include the Eagle-Picher Lead Co., the St. Louis Smelting & Refining Co. (a subsidiary of the National Lead Co.), and the United States Smelting, Refining & Mining Co.

WORLD ASPECTS

WORLD SMELTER PRODUCTION

The following table shows the world smelter production of lead from 1924 to 1928, so far as statistics are available. Official figures are used wherever possible. For countries for which official data are not yet available the figures are taken from the yearbook of the American Bureau of Metal Statistics and other reliable sources, but in later reports the official statistics will be substituted as received.

There is always a possibility of duplication in figures showing world production, for some countries send "work lead" or base bullion to other countries for refining. Furthermore, secondary and antimonial lead are often included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary lead and antimonial lead. The figures for the United States represent refined lead that was smelted in this country, whatever the source of the ore.

*World production of lead, 1924-1928, in metric tons*¹

[Compiled by L. M. Jones, of the Bureau of Mines]

Country ²	1924	1925	1926	1927	1928
Argentina.....	4,536	7,700	8,200	8,700	8,991
Australia.....	130,494	151,269	155,398	167,616	157,565
Austria.....	4,985	5,408	6,478	8,086	8,135
Belgium.....	77,950	87,480	87,876	91,710	³ 92,000
Canada.....	75,503	104,303	123,644	134,157	136,561
Chosen.....	(9)	485	1,958	824	719
Czechoslovakia.....	2,264	2,212	2,316	2,502	3,065
France.....	18,881	20,543	19,495	24,973	22,911
Germany.....	67,427	89,458	96,200	109,474	³ 110,000
Great Britain.....	5,387	4,811	4,334	6,132	5,600
Greece.....	5,106	5,366	5,059	5,325	7,306
India (Burma).....	52,590	48,034	55,202	67,026	79,643
Indo-China.....			1	4	³ 5
Italy.....	22,062	24,475	23,590	23,774	21,220
Japan.....	2,941	3,337	3,610	3,394	³ 4,000
Mexico.....	133,440	163,242	182,886	210,966	223,024
Northern Rhodesia.....	5,999	3,406	3,897	5,971	4,751
Norway.....	642	406	385	³ 300	³ 300
Peru.....	149	³ 150	³ 150	161	13,608
Poland.....	21,264	28,637	27,924	29,574	36,373
Portugal.....	31	60	140	60	³ 60
Rumania.....	433	489	655	828	537
Russia ⁴	685	1,021	1,342	1,217	³ 2,000
Southwest African Protectorate.....	⁴ 813	⁴ 1,619	⁴ 1,682	⁴ 3,535	⁴ 4,654
Spain.....	141,849	153,567	149,514	144,023	130,950
Sweden.....	477	723	522	330	-----
Tunisia.....	14,291	16,013	18,106	18,662	17,606
Turkey.....	5,104	4,786	6,014	7,852	6,962
Union of South Africa.....	4,609	-----	-----	-----	-----
United States (refined).....	555,913	636,790	661,239	635,651	592,238
Yugoslavia.....	11,487	10,956	9,809	10,672	13,875
	1,367,000	1,577,000	1,657,000	1,724,000	1,705,000

¹ By countries where smelted but not necessarily refined.² In addition to the countries listed, China smelts lead, but no reliable data of output are available. Official estimates of production in 1925 range from 1,500 to 3,500 tons.³ Approximate production.⁴ Data not available.⁵ Year ended Sept. 30.⁶ Year ended Mar. 31 of year following that stated.⁷ Exports.

The world smelter production of lead in 1928, as compiled by the Bureau of Mines, amounted to 1,705,000 metric tons, about 1 per cent under the 1927 output. The American Bureau of Metal Statistics estimates the 1928 output at 1,675,277 metric tons, less than 1 per cent under its estimate of production for 1927. The Metallgesellschaft, of Frankfort am Main, reports the 1928 world output as 1,645,700 metric tons or about 1.5 per cent under the 1927 output.

In 1928, eight countries produced nearly 90 (89.3) per cent of the world's supply of lead, as follows: United States, 34.7 per cent; Mexico, 13.1 per cent; Australia, 9.2 per cent; Canada, 8.0 per cent; Spain, 7.7 per cent; Germany, 6.5 per cent; Belgium, 5.4 per cent; and India (Burma), 4.7 per cent. Other countries which produced 1 per cent or more of the world total were as follows: Poland, 2.1 per cent; France, 1.3 per cent; Italy, 1.2 per cent; and Tunisia, 1.0 per cent. Yugoslavia and Peru each produced 0.8 per cent.

The largest tonnage decrease in 1928 (43,400 metric tons or 7 per cent) was in the United States.

Spain fell off 13,000 tons, or 9 per cent, and Australia, 10,000 tons, or 6 per cent. The 1928 outputs of Germany and Belgium were about equal to those of 1927. Italy and France showed decreases of 11 and 8 per cent, respectively. The largest tonnage increase in 1928 was in Peru, which for the first time became an important producer, with an

output of 13,600 tons. India (Burma) increased its output 12,600 tons or 19 per cent; Mexico, 12,000 tons or 6 per cent; Poland, 6,800 tons or 23 per cent; Yugoslavia, 3,200 tons or 30 per cent; and Canada, 2,400 tons or 2 per cent.

SUMMARY OF LEAD INDUSTRY IN IMPORTANT LEAD-PRODUCING COUNTRIES

ARGENTINA

Argentina ranked second in South American lead production in 1928, with an output of about 9,000 metric tons. Of this total about 4,000 tons was refined from domestic ores, the remainder being obtained from ores imported from Bolivia. Production of lead ore totaled 4,030 tons, as compared with 3,392 tons in 1927. The Cia Minera y Metalurgica Sud Americana, a subsidiary of the National Lead Co. of New York, was the principal producer of ores, and it produced 5,205 tons of pig lead in 1928.

AUSTRALIA

Australia ranked third in lead production in 1928, with an output of 157,565 metric tons, or 9 per cent, of the world total. All but a small part of the lead ore mined in Australia, most of which was derived from the ores of the Broken Hill district, New South Wales, was smelted at Port Pirie, the only active lead smelter in Australia. Only a relatively small amount of ore was exported to Europe in 1928, but the larger part of the smelter output was sent abroad, 85 per cent going to Europe.

The production and ore reserves of the four principal producers in the Broken Hill district in 1928 are shown in the following table.

Production and ore reserves of the four principal producers in the Broken Hill district in 1928

	Zinc Corporation	Broken Hill South		Sulphide Corporation		North Broken Hill	
	Ore	Ore	Dump slime	Ore	Dump material	Ore	Dump material
Material treated.....long tons..	274,371	327,150	45,319	131,115	25,903	415,332	85,898
Lead content.....per cent..	15.7	14.4	7.8	14.8		13.4	9.4
Zinc content.....do.....	10.6	11.6	12.1	15.6		10.2	15.0
Silver content.....ounces..	3.4	5.8	4.1	12.7		7.6	7.4
Lead concentrates produced.....long tons..	62,215	67,145		29,280		77,760	10,690
Lead content.....per cent..	65.1	65.8		59.5		65.1	58.2
Zinc content.....do.....	6.6	6.7		9.1		7.6	12.2
Silver content.....ounces..	13.6	25.5		50.1		32.6	42.6
Lead recovered.....per cent..	94.0	93.9		74.8		91.1	77.4
Silver recovered.....do.....	89.8	90.4		73.2		80.2	71.9
Zinc concentrates produced.....long tons..	48,713	61,996	9,306	39,961		67,160	22,940
Zinc content.....per cent..	48.2	49.4	39.5	49.7		48.2	47.1
Lead content.....do.....	3.4	2.3	13.3	4.7		4.1	4.4
Silver content.....ounces..	1.4	1.8	11.8	7.8		5.1	4.8
Zinc recovered.....per cent..	81.0	81.0	66.9	80.9		76.9	83.9
Lead recovered.....do.....			35.1				
Silver recovered.....do.....			58.9				
Ore reserves.....long tons..	¹ 2,912,769	² 4,250,000		³ 1,405,470		⁴ 2,000,000	
Lead content.....per cent..	113.9	(⁴)		(⁴)		(⁴)	
Zinc content.....do.....	111.3	(⁴)		(⁴)		(⁴)	
Silver content.....ounces..	13.0	(⁴)		(⁴)		(⁴)	

¹Tons as of Dec. 31, 1928; assays as of Dec. 31, 1927.

²As of June 30, 1929.

³As of June 30, 1928.

⁴Assays not given.

There was no amelioration of the unfavorable labor situation in Australia, outlined in the chapter of this series for 1927. This condition and the lower metal prices in 1928 resulted in reduced profits for many of the operators and in idleness at several mines, including the Proprietary of the Broken Hill Proprietary (Ltd.) and the Block 14 of the Broken Hill Proprietary Block 14 (Ltd.). However, in July, 1929, it was announced that these two mines would be operated through the Central mine of the Sulphide Corporation and that the ore would be treated in that company's mill. At the close of 1928 several of the active companies were improving their mine and mill plants to effect a reduction in costs.

The Mount Isa district, Queensland, has shown increasing importance as a result of the development program of the Russo-Asiatic Consolidated (Ltd.). In January, 1929, ore reserves as of November 29, 1928, were announced⁷ as follows: Carbonate ore, 3,500,000 tons averaging 9 per cent lead and 3.6 ounces of silver per ton; sulphide ore assured to 750 feet, 12,200,000 tons averaging 6.1 per cent lead, 8.2 per cent zinc, and 3.7 ounces of silver; 5,000,000 tons additional sulphide ore of same assay expected above the 750-foot level; and in addition approximately 500,000 tons of sulphide ore of much higher grade. The development program includes a 54-mile railway from Dutchess to Mount Isa (completed in April, 1929), a 10,000-kilowatt turbo-steam power plant operating on coal dust, a dam at Rifle Creek to provide a water supply by impounding the run-off during the rainy season, a mill that will eventually treat 2,000 tons of ore per day, and a lead smelter at the mine to produce a lead-silver bullion. The first unit of the mill will operate on carbonate ore, and with lead at £20 per ton and silver at 2 shillings per ounce profits are expected to be about 30 shillings per ton of ore treated.⁷ Production is expected in 1930.

In Tasmania the Electrolytic Zinc Co. of Australasia (Ltd.) is developing the Read Rosebery lead-zinc-silver deposits. A new mill is being erected at Rosebery to handle 100,000 tons of ore annually. Production is expected in 1930.

BELGIUM

Belgium ranked third in European lead production and seventh in world production in 1928. Its output in 1928 has been estimated at 92,000 metric tons, about equal to its 1927 output and 5.4 per cent of the world total. The mines of Belgium produce little lead ore, so that the smelting industry depends on imports for its raw material. In 1928 Belgium imported 58,400 tons of lead ore and 18,500 tons of pig lead (probably mostly base bullion) and scrap. Bolivia, Australia, and Great Britain were the principal sources of the ore, and Australia and Germany were the two largest sources of the pig lead. Another important source of lead in Belgium is the residue from the smelting of zinc ores. The net pig lead export of Belgium in 1928 was about one-fourth of its total pig lead production.

⁷ Engineering and Mining Journal, vol. 127, Feb. 9, 1929, p. 253.

BOLIVIA

Bolivia is the largest South American exporter of lead ore and in 1928 shipped 17,415 metric tons of 71.35 per cent concentrates, as compared to 22,682 tons of 67.10 per cent grade in 1927. Belgium, Argentina, and Great Britain were the principal importers of these concentrates.

CANADA

Canada produced 150,533 short tons of pig lead in 1928, an increase of 2 per cent over 1927 and nearly three times the output of 1923. Canada ranked fourth in world production in 1928. This output of pig lead represented about 96 per cent of the total Canadian mine production, as about 7,500 tons of lead in ore was exported, chiefly to the United States. Canada exported about 128,000 short tons of pig lead in 1928, or 85 per cent of the smelter output. Great Britain and Japan were the principal consumers of Canadian pig lead and together took three-fourths of the total exported.

By far the greatest part of the lead production of Canada is derived from the Sullivan mine of the Consolidated Mining & Smelting Co. in British Columbia. In 1928, 1,554,070 short tons of ore from this mine was treated, producing 204,657 tons of lead concentrates and 198,010 tons of zinc concentrates. The company owns large reduction plants at Trail and Tadanac, British Columbia, where the ore from its own and from independent mines is treated. The company's production during the past two years has been reported as follows:⁸

	1927	1928
Ore.....short tons.....	1,405,872	1,665,586
Gold.....ounces.....	29,490	23,623
Silver.....do.....	7,179,607	7,673,762
Lead.....pounds.....	291,043,120	318,831,578
Copper.....do.....	18,522,742	17,806,306
Zinc.....do.....	147,054,623	163,530,890

There are a number of districts in British Columbia where complex lead-zinc ores are being or are soon to be treated by selective flotation. In the Slocan district five new mills were put into operation in 1928. There was also considerable activity in the Kootenay and Monarch districts, where several small ore bodies were developed. At the Reeves-McDonald property, on the Pend d'Oreille River near the international boundary, an ore body has been developed which is said to contain 2,000,000 tons of proven ore, with indications of still larger reserves. The metal content averages 7 per cent zinc, 2 per cent lead, and 0.5 ounce of silver.

Ontario has the only other lead smelter in Canada. It is at Galetta and treats mainly ores from the Galetta mine. In 1928, the mine production of the Province was about 3,400 short tons of lead. In the Sudbury district there has been recently considerable development of lead-zinc deposits, and this district may soon become an important producer. The most important development to date is the Errington mine of the Treadwell Yukon Co., which is controlled by the Bunker Hill & Sullivan Mining & Concentrating Co., of Idaho.

⁸ Engineering and Mining Journal, vol. 127, Apr. 27, 1929, p. 699.

This property has been developed by shafts to a depth 500 feet, and diamond drilling has proved ore to a depth of 1,200 feet. Data as to the extent of the ore body are not available, but it has been announced that 1,000,000 tons were developed in one ore body above the 300-foot level. The samples averaged: Gold, 0.021 ounce; silver, 2.15 ounces; copper, 1.33 per cent; and zinc, 5.74 per cent. Other parts of the property contain considerable lead. During 1928 a 300-ton pilot mill was operated and produced lead, copper, and zinc concentrates, but the metallurgical results were not entirely satisfactory.

Sudbury Basin Mines (Ltd.) is developing by diamond drilling a property adjoining the Errington mine and a large amount of ore has been indicated. No attempt has been made to estimate tonnage, but a continuous length of ore of 1,500 feet to a depth of at least 500 feet has been reported. Known ore bodies range from 20 to 70 feet in width. In character and grade this ore is said to resemble closely the Errington ore.

Sudbury Contact Mines, which adjoins Sudbury Basin on the south, is the only other property in this area on which work is being done. At Lake Geneva, outside the Sudbury district proper, Towagmac Exploration is developing a property, and some ore has been encountered.

The Province of Quebec produced 3,100 short tons of lead in ore which was exported. The Tetreault mine at Notre Dame des Anges was the only producer. Considerable activity was shown in the Gaspé Peninsula in 1928.

The Mayo district of the Yukon Territory produced 3,500 short tons of lead in ore which was exported.

The copper-zinc ore bodies recently developed in Manitoba at the Flin Flon, Sherritt-Gordon, and Mandy properties have to date shown practically no lead content.

In Nova Scotia the British Metal Corporation (Ltd.) announced plans for the erection of a 250-ton flotation plant at the Sterling mine on Cape Breton Island.

FRANCE

France produced about 23,000 metric tons of lead in 1928, a decrease of 8 per cent from 1927 and about 1 per cent of the world's total. This output supplied less than one-fourth of the country's needs; the balance was supplied by imported lead, chiefly from Mexico, Spain, and Tunisia. The lead-smelting industry of France depends to some extent on imported ore; in 1928 this came chiefly from Algeria, Italy, and Tunisia. The principal lead mines of France are in the southern part of the country.

In 1927 Russo-Asiatic Consolidated (Ltd.) acquired control of the Compagnie Nouvelle des Mines de Villemagne and Mines de St. Sebastien d'Aigrefeuille. At that time underground work on a section of the Villemagne ore body indicated 3,000,000 tons of ore containing 12½ per cent combined lead and zinc and 3 ounces of silver. For the year 1928 this company reported that the mill had been enlarged to 500 tons daily capacity; 106,000 tons of ore was milled and 9,307 tons of zinc concentrates and 2,830 tons of lead concentrates were produced. The 1929 output was expected to reach 145,000 tons of ore. At St. Sebastien 1,500,000 tons of ore averaging 4 per cent lead, 1½ per cent zinc, and 2½ ounces of silver has been

developed, with possibilities for a much greater tonnage. The ore occurs in a flat bed ranging from 2 to over 5 meters in thickness. The formation is 5 kilometers long and 300 to 400 meters wide. The ore is apparently just under grade for profitable operation at the present price of lead, but large-scale operations are expected if and when lead prices become stabilized at a higher level.

GERMANY

Germany produced approximately 110,000 metric tons of pig lead in 1928, or less than half of the lead it consumed. Total imports amounted to 148,500 tons, of which the United States supplied 30 per cent; Mexico, 19 per cent; Australia, 17 per cent; and British India, 13 per cent. Germany ranks second to Great Britain as an importer of pig lead.

The lead-smelting industry of Germany is supported largely by domestic ores. In 1928 Germany imported 48,800 tons of lead ore and exported 17,150 tons, leaving a net import of 31,650 tons, the lead content of which was less than 20 per cent of the smelter output. Germany lost the greater part of its most important lead-producing area when Poland was ceded a large portion of Upper Silesia in 1922. The development of zinc production now taking place in the German portion of the Upper Silesia deposits will result in an increased lead output from that area.

INDIA

The lead production of India increased 19 per cent in 1928 and amounted to nearly 5 per cent of the world total. A very large part of this output was exported, 66 per cent of the exports going to Great Britain and 15 per cent to Germany.

The only lead producer of any importance in India is the Burma Corporation (Ltd.). Its mines are at Bawdwin in the Upper Shan States of Burma. During the year ended June 30, 1928, the company mined 429,845 long tons of ore averaging 23.5 per cent lead, 21.5 ounces of silver, 14.9 per cent zinc, and 1.3 per cent copper. At the mill 58,222 tons of zinc concentrates was produced, with an average content of 50.49 per cent zinc, 6.48 per cent lead, and 11.29 ounces of silver. Only 55 per cent of zinc in the ore treated was recovered in the zinc concentrates, owing to the refractory nature of the ore. At the lead smelter 72,388 tons of refined lead and 6,954,665 ounces of refined silver were produced, as well as 12,388 tons of copper matte and 773 tons of refined antimonial lead. Improvements in smelting practice resulted in the production for the first time of a copper-nickel speiss. Ore reserves, as of June 30, 1928, were estimated at 4,092,751 tons assaying 21.5 ounces of silver, 25.9 per cent lead, and 16 per cent zinc.⁹

ITALY

Production of lead in Italy decreased from 23,800 metric tons in 1927 to 21,200 tons in 1928, a drop of 11 per cent. The 1928 output was 1 per cent of the world total and was less than half of the country's consumption. More than 27,000 tons of lead was imported in 1928, 85 per cent of which came from Spain. Italy exported 19,000 tons of lead ore in 1928, or about one-third of its total mine output.

⁹ Annual report of the Burma Corporation (Ltd.) for year ended June 30, 1928.

The Iglesias district on the Island of Sardinia is the largest producer of lead ore in Italy. In 1927 this district produced more than 90 per cent of the Italian total. The Province of Trieste ranked second, with about 4 per cent of the total.

MEXICO

Mexico has ranked second in world lead production for several years. In 1928 it produced 223,000 metric tons of pig lead, 13 per cent of the world total and 6 per cent more than the 1927 output. According to preliminary official figures the mine production of lead decreased about 3 per cent. Practically all of the pig lead smelted in Mexico is exported. It is estimated that 50 per cent of the total exported in 1928 went to the United States, 12 per cent to Germany, and 11 per cent to France.

Heretofore a large part of the lead exported from Mexico was in the form of base bullion which was refined abroad, but a change in this situation is expected, as it was reported that the American Smelting & Refining Co. was building a refinery at Monterrey and the American Metal Co. was making additions to its smelter and refinery, also at Monterrey. It is believed that these moves were made to take advantage of the lower export duty on the refined metal.

During 1928 the Cia Mexicana de Minerales, S. A., which is controlled by Belgian interests, was erecting a lead smelter of 100 tons daily ore capacity at Mazatlan. This was expected to stimulate lead mining in the States of Sonora, Sinaloa, and Nayarit. It was reported that the Mexican Premier Co. was going to erect a lead smelter at its San Jose property near Mazatlan. The concentrates from the company's flotation plant were being shipped to the Potosi smelter of the American Smelting & Refining Co. Another new smelting operation in Mexico was that of the British Sulphides Smelting Co. (Ltd.), which began in June, 1928. The plant handled about 50 tons of ore and produced about 5 tons of lead bullion daily, which was refined into litharge and silver.

The preliminary estimate of 1928 mine production of lead in Mexico is 236,486 metric tons, as compared to 243,346 tons in 1927. In 1927 only 6 States produced as much as one-half of 1 per cent of the total, as follows; Chihuahua, 56 per cent; Zacatecas, 15 per cent; Coahuila, 10 per cent; Durango, 9 per cent; San Luis Potosi, 6 per cent; and Nuevo Leon, 2 per cent. Chihuahua will probably show a decline in 1928, as a result of decreased production at the Erupcion and Año Nuevo mines.

NEWFOUNDLAND

The Buchans mine promises to become an important producer. This property is held by a partnership consisting of the Anglo-Newfoundland Development Co. (Ltd.), which owns the property, and the American Smelting & Refining Co., which operates the property and provides the capital necessary for development. Net profits are shared equally. At the annual meeting of the Anglo-Newfoundland Development Co. (Ltd), held in London in January, 1929, H. A. Guess, vice president of the American Smelting & Refining Co., reported that development to date indicated a reserve of 5,750,000 tons of ore averaging 7.65 per cent lead, 17.85 per cent zinc, 0.033 ounce of gold, 3.25 ounces of silver, and 1.4 per cent copper.

During the latter part of 1928 the first unit of the 500-ton mill was completed and treated about 250 to 300 tons of ore daily. An increase in capacity to 1,000 tons daily was being considered.

PERU

Peru became the largest South American lead producer in 1928 as a result of the blowing in of a lead furnace at the Cerro de Pasco Copper Corporation's smelter at Oroya. A second furnace was authorized by the company and was expected to be in operation in the latter part of 1929. The company's principal lead-mining operation was at Casapalca. The construction of a Betts electrolytic lead refinery and a 1,000 or 2,000 ton per day concentrator to treat the complex lead-zinc ores at Cerro de Pasco was being considered at the end of the year.

Peru produced 13,608 metric tons of pig lead in 1928 and exported 11,500 tons, of which the United States took about 65 per cent and Great Britain 10 per cent. Peru also exported about 7,200 tons of lead ore and concentrates, of which about 30 per cent went to the United States.

POLAND

Practically the entire lead output of Poland comes from the Upper Silesian district, where lead is a by-product of the zinc industry. The total smelter output of lead in 1928 amounted to 36,373 metric tons, an increase of 23 per cent over 1927 and 2 per cent of the world total. Zinc production increased 8 per cent in 1928. Poland exported about two-thirds of its lead output, Czechoslovakia, Austria, and Germany being the principal consumers. Poland imported about 16,300 tons of lead ore in 1928, about 85 per cent of which came from Germany.

Giesche Spolka Akcyjna, a subsidiary of the Anaconda Copper Mining Co., produced 6,329 tons of lead or 17 per cent of the total Polish output in 1928. A brief historical sketch of this American enterprise is given in the Mineral Resources chapter on zinc for 1928.

SPAIN

The steady decline in the price of lead during the past few years, together with the appreciation in the value of the peseta, higher wages, and increased costs of fuel and transportation have resulted in a marked curtailment in Spanish lead production. In 1928 Spain produced 131,000 metric tons of lead, a decrease of 9 per cent from 1927 and 15 per cent less than the 1925 output.

Early in 1927 the Spanish Government attempted to rehabilitate the lead industry by issuing a royal decree by which the Spanish-owned properties, representing about 50 per cent of the total lead production, were organized into two syndicates for one year, ended June 30, 1928. The State was to advance to each mine a sum covering the difference between production cost and selling price, but the maximum liability was not to exceed 3,000,000 pesetas and the cost of production was not to exceed 800 pesetas per ton of lead. As the end of the period drew near it was apparent that the lead industry was still in need of protection, so stronger measures were adopted in a royal decree of March 9, 1928, under which a Spanish lead consortium was formed. State aid to the high-cost producers was not

continued, but the consortium was granted monopolistic privileges in the Spanish market.

A brief résumé of the principal provisions regarding the consortium follows.¹⁰

The consortium is to be composed of the Government mine Arrayanes, the syndicates mentioned, and companies engaged in mining, ore treatment, and manufacturing, which request participation. If such companies participate, it will comprise the bulk of the Spanish lead industry.

Objects of the Consortium.—The expressed objects of the consortium are the purchase and sale of all lead, in bars or manufactured, which the national market consumes. Purchase is to be made monthly from the entities composing the consortium, in the proportion in which they have sold in the national market in 1927. The decree further states that the consortium shall have as its functions the purchase and sale of lead in bars (and of silver) required by the national market, purchase and sale of old lead, purchase and sale of manufactured lead (tubes, sheets, shot) required by the national market, and administration of a reserve fund and a special fund for aid to the industry.

Governed by Council.—The consortium will be governed by a council of administration, including a representative of the mine Arrayanes, the presidents of the two syndicates, and four representatives of the mining, treating, and manufacturing entities—all to be of Spanish nationality, or to have lived at least nine years in Spain. The remainder of the council is to be made up of three representatives of the State, one of whom shall be president of the consortium and have double vote in deliberations.

Lead Prices to be Fixed Monthly.—The participating ore-treating companies must, according to their zones, treat the ore from Arrayanes and of the two syndicates, the terms to be periodically formulated by the council of administration. Prices of lead in bars bought by the consortium from the member companies shall be fixed monthly by the council, by deducting such expenses as transportation, insurance, and duties from the average price quoted by the London Metal Exchange for the month of delivery. The consortium will have the exclusive privilege of supplying lead required by enterprises which enjoy national protection, also that for urban installation for water and other fluids.

Sales prices will be fixed by the Ministry of Fomento on such a basis as to yield a profit to the consortium, and a portion of the profits shall be set aside to constitute a fund to be used in granting aid to the syndicates. This fund will take the place of the Government credit provided earlier and is to be used in the same manner. If prices of ore increase to an extent to provide a profit to the mines composing these syndicates, provision is made for retaining part of these profits until the advances from the fund are repaid.

Consortium of Indefinite Duration.—The consortium is to be of indefinite duration. Members may not withdraw without giving one year's notice, and such notice may not be given until after the expiration of at least five years. The necessary capital for its establishment, purchase, and manufacture of lead, and other purposes may be obtained from bank loans guaranteed by the credit of the consortium, or from loans by enterprises constituting the consortium, bearing current interest rates. The Ministry of Fomento is required to adopt the necessary measures for immediate formation of the consortium.

In 1928 Spain exported about 70 per cent of its smelter production of lead; Italy, France, Great Britain, and Russia were the principal consumers.

TUNISIA

Smelter production of lead in Tunisia in 1928 amounted to 17,606 metric tons, a decrease of 6 per cent from 1927. Practically all of the output was exported, over 90 per cent of it going to France. Production of lead ore decreased to 34,000 tons—8 per cent less than that in 1927 and the lowest output since 1922. The decrease is attributed to exhaustion of the oldest and most extensive deposits, labor shortage, and increased costs of transportation. Some Govern-

¹⁰ Commerce Reports, May 7, 1928, p. 365.

ment relief has been attempted in the form of reduced taxation of prospecting permits and reduction of transport charges on low-grade ores. Development of new areas has been retarded by lack of adequate transportation.

Tunisia exports some ore to Belgium, France, and Germany.

YUGOSLAVIA

Production of lead in Yugoslavia in 1928 was nearly 14,000 metric tons, or 30 per cent more than that in 1927. Exports were 8,800 tons, of which Austria and Hungary took 96 per cent. The Central European Mines (Ltd.) was the principal producer, its smelter at Mezica having produced 9,734 tons of virgin soft lead.

Trepca Mines (Ltd.), a subsidiary of Selection Trust (Ltd.), was reported as developing the Stantrg lead-zinc-silver deposit near the town of Kosovska Mitrovica. The ore body is a replacement in limestone. Reserves were estimated at 1,750,000 tons, averaging 11.5 per cent lead, 10.5 per cent zinc, and 3 ounces of silver per ton.¹¹

IMPORTS

The United States imports much lead in various forms, principally in base bullion and ore. Some of it is entered for immediate consumption; most of it, however, is entered for warehouse, is smelted and refined in bond, and is then reexported as refined pig lead or in manufactured products.

GENERAL IMPORTS

The following table shows the general imports of lead into the United States, by classes, including both imports for immediate consumption and imports for warehouse. Of the total lead imported in 1928, as shown in the table, 82.9 per cent was in base bullion, 16.7 per cent in ore, and 0.4 per cent in pigs, bars, sheets, and old. Imports in base bullion increased 9 per cent in 1928, while imports in ore decreased 36 per cent.

Lead imported into the United States, 1919-1928, by classes, in pounds

[General imports]

Year	Lead in ore	Lead in base bullion	Pigs, bars, sheets, and old	Total lead content
1919.....	19,573,856	112,024,518	10,214,753	141,813,127
1920.....	29,488,816	96,103,603	71,437,108	197,029,527
1921.....	14,234,039	71,733,838	62,602,534	148,570,411
1922.....	24,474,481	124,074,465	7,101,623	155,650,569
1923.....	66,882,850	161,496,495	42,198,848	270,578,193
1924.....	95,320,168	155,501,350	24,493,746	275,315,264
1925.....	88,962,502	141,253,559	14,042,369	244,258,430
1926.....	116,232,669	156,570,738	22,304,620	295,108,027
1927.....	81,276,126	236,567,252	4,934,749	322,778,127
1928.....	51,829,530	256,935,461	1,323,158	310,088,149

General imports of lead by countries of origin are shown in the next table. Mexico supplied nearly 89 per cent of the total, South

¹¹ Mining Magazine (London), vol. 41, August, 1929, p. 72.

America (principally Peru) nearly 6.6 per cent, Canada about 4.6 per cent, and Europe and other countries only small amounts. Imports from Mexico decreased 8 per cent from 1927, while those from Canada and South America increased 131 and 40 per cent, respectively.

Lead imported into the United States, in ore, base bullion, and refined, 1919-1928, by sources, in pounds

[General imports]

Year	Canada	Mexico	South America	Europe	Other countries	Total
1919-----	10,391,115	125,541,614	5,504,416	89,840	286,142	141,813,127
1920-----	8,199,234	131,815,278	7,085,351	38,766,504	11,163,160	197,029,527
1921-----	8,127,158	106,406,238	2,381,365	30,224,701	1,430,949	148,570,411
1922-----	8,663,236	141,216,136	3,803,478	1,454,384	513,335	155,650,569
1923-----	11,399,671	242,352,788	5,300,161	11,004,938	520,635	270,578,193
1924-----	11,022,091	243,161,069	15,820,867	4,857,805	453,432	275,315,264
1925-----	11,646,820	218,873,800	10,621,737	1,594,963	1,521,110	244,258,430
1926-----	12,316,740	254,203,852	24,790,075	3,224,504	572,856	295,108,027
1927-----	6,214,867	300,634,815	14,583,513	1,226,049	118,883	322,778,127
1928-----	14,352,967	275,184,287	20,408,574	56,406	85,915	310,088,149

The following tables show the imports of lead in ore, matte, and base bullion, by countries.

Lead imported into the United States, in ore and matte, 1924-1928, by countries, in short tons

[General imports]

Country	1924	1925	1926	1927	1928
Mexico-----	34,629	32,971	40,239	30,615	17,055
Canada-----	4,383	4,978	5,524	2,558	7,131
Peru-----	387	1,887	3,642	3,415	1,170
Chile-----	7,516	3,216	7,596	3,877	504
Other countries-----	745	1,429	1,115	173	55
	47,660	44,481	58,116	40,638	25,915

Mexico has supplied a large part of the imported ore, but imports from this source showed a large decrease in 1928. Imports from South America also decreased, but those from Canada increased materially.

Lead imported into the United States, in base bullion, 1924-1928, by countries, in short tons

[General imports]

Country	1924	1925	1926	1927	1928
Mexico-----	77,406	70,505	77,663	117,933	119,935
Peru-----			435		8,525
Spain-----				336	
Other countries-----	345	122	187	10	8
	77,751	70,627	78,285	118,284	128,468

Mexico supplies the bulk of the imported base bullion, and the quantity imported in 1928 was the greatest recorded to date. Peru furnished a substantial tonnage as the result of the beginning of large-scale lead-smelting operations in that country by an American copper company.

IMPORTS FOR CONSUMPTION

Statistics on imports for consumption, as shown in the tables that follow, include imports entered for immediate consumption and withdrawals from warehouse for domestic consumption. As most of the lead imported is smelted and refined in bond and reexported the total imported for consumption is considerably less than general imports. In 1928 imports for consumption were equivalent to only about 26 per cent of the general imports of lead.

Lead remaining in warehouse in the United States, December 31, 1919-1928, in pounds

[Stated in the form in which the material was entered for warehouse]

Year	Ore (lead content)	Base bullion (lead content)	Pigs, bars, and old	Year	Ore (lead content)	Base bullion (lead content)	Pigs, bars, and old
1919.....	29,543,811	61,408,873	468,154	1924.....	103,474,370	95,007,016	10,090,668
1920.....	32,923,299	69,517,026	2,644,576	1925.....	105,884,711	91,725,008	116,565,672
1921.....	13,679,465	24,692,350	693,440	1926.....	114,630,697	107,582,653	121,820,057
1922.....	10,470,144	7,076,544	-----	1927.....	99,526,339	126,669,674	119,326,011
1923.....	76,031,259	80,306,856	5,234,475	1928.....	97,645,207	137,500,524	8,278,733

¹ Includes lead in reclaimed scrap, as follows: 1925, 241,078 pounds; 1926, 397,433 pounds; 1927, 397,712 pounds. Corresponding figures for earlier years and for 1928 are not recorded separately.

Lead imported for consumption in the United States, 1919-1928, by classes

Year	Lead in ore ¹		Lead in base bullion		Pigs, bars, and old ²		Sheets, pipe, and shot		Not otherwise specified	Total value
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
1919....	4,106,823	\$196,363	31,796,693	\$1,130,937	10,174,115	\$415,094	8,018	\$628	\$17,187	\$1,760,206
1920....	13,700,499	908,619	66,816,820	3,340,600	68,901,959	3,887,821	81,396	5,483	21,328	8,163,851
1921....	6,842,507	327,046	56,819,980	1,668,410	61,909,094	1,972,716	3,087	140	11,204	3,979,516
1922....	23,649,851	812,603	55,859,422	1,815,142	8,563,110	335,924	6,018	697	12,286	2,976,652
1923....	22,420,046	1,190,414	11,124,151	626,201	42,925,265	2,510,466	19,525	4,495	90,027	4,421,603
1924....	65,147,976	3,145,791	28,796,402	1,542,167	27,362,392	1,850,862	11,666	4,384	138,637	6,681,841
1925....	12,706,508	672,112	24,747,665	1,823,566	15,464,205	1,038,350	27,579	10,429	139,533	3,683,990
1926....	58,752,911	3,393,039	13,341,038	972,758	24,365,570	2,191,658	864,342	101,322	62,895	6,721,672
1927....	70,260,478	4,203,897	14,629,606	925,328	9,933,679	635,807	988,170	104,890	52,626	5,922,548
1928....	46,511,508	2,626,231	13,397,455	560,983	20,488,373	808,359	775,329	67,131	134,995	4,197,699

¹ Includes also lead in matte beginning Sept. 22, 1922.

² Includes also imports of antimonial lead, antimonial scrap lead, babbitt metal, solder, etc., beginning with tariff of Sept. 22, 1922, except in 1925, 1926, 1927, and 1928, when antimonial lead is excluded.

Type metal¹ imported for consumption in the United States, 1919-1928

Year	Type metal		Lead content	
	Pounds	Value	Pounds	Percentage
1919.....	13,394,803	\$816,642	11,000,498	82.1
1920.....	29,887,353	1,349,495	25,761,543	86.2
1921.....	38,971,351	1,191,553	30,706,845	78.8
1922.....	44,895,120	1,120,814	33,944,199	75.6
1923.....	(2)	(2)	7,353,463	(2)
1924.....	(2)	(2)	1,288,766	(2)
1925 ¹	6,009,161	463,134	4,309,549	71.7
1926 ¹	8,621,175	912,331	7,053,849	81.8
1927 ¹	878,346	65,049	666,654	75.9
1928 ¹	3,990,548	193,177	3,086,770	77.4

¹ Classification for 1925 to 1928 is "Type metal and antimonial lead"; separate figures not recorded.

² Figures not available.

EXPORTS

The chief lead export of the United States is refined pig lead, a large part of which is derived from the smelting of foreign ore and base bullion. In 1928 there was a large decrease in the exports of foreign lead, notwithstanding a large increase in the production of refined pig lead from foreign raw materials. At the same time there was a large increase in the export of domestic refined lead. Foreign lead exported in manufactures (chiefly lead pigments and foil) with benefit of drawback amounted to more than 13,000 tons in 1928.

Total exports of domestic and foreign pig lead decreased 7 per cent in 1928. Europe, Asia, and South America, the principal customers, took 75, 20, and 4 per cent of the total, respectively. Exports to Europe and South America decreased considerably, while those to Asia increased. United Kingdom and Germany were the principal European consumers. Exports to the former increased 13 per cent in 1928 and those to the latter decreased 28 per cent. Exports to Japan in 1928 were 26 per cent greater than those in 1927 and represented 18 per cent of the total United States export. The decrease in exports to South America in 1928 was due largely to decreases of 86 per cent and 27 per cent in exports to Chile and Argentina, respectively. Brazil was the largest South American importer of United States lead in 1928.

Refined lead, from domestic ores, exported from the United States, 1919-1928

Year	Short tons	Value	Year	Short tons	Value
1919.....	10,510	\$1,471,256	1924.....	5,332	\$711,147
1920.....	2,730	462,223	1925.....	4,955	784,440
1921.....	1,624	177,926	1926.....	4,276	601,061
1922.....	5,823	604,605	1927.....	2,533	308,698
1923.....	1,999	260,487	1928.....	14,202	1,299,021

Foreign lead exported from the United States, 1919-1928

Year	Exported from warehouse			Exported in manufactures with benefit of drawback (pounds)
	Pigs, bars, and old ¹		All other manu- factures	
	Pounds	Value		
1919.....	81,951,396	\$4,536,273	\$44	3,872,130
1920.....	34,725,501	2,570,535	35,146	12,350,794
1921.....	50,000,259	2,284,107	613	18,738,927
1922.....	64,709,305	3,177,360	146	11,354,070
1923.....	97,471,326	5,195,256	(2)	25,052,107
1924.....	153,515,863	9,685,619	(2)	30,549,116
1925.....	197,128,517	14,910,891	(2)	23,398,305
1926.....	135,319,321	8,904,603	(2)	35,910,934
1927.....	245,467,875	12,508,566	(2)	24,008,803
1928.....	204,134,083	9,060,200	(2)	26,448,902

¹ Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed all foreign lead smelted or refined in this country and exported as "domestic exports of pigs, bars, etc., produced from foreign ore." The figures include also the exports of foreign lead imported in the form of pigs and bars.

² Not separately classified after 1922.

Foreign lead exported in manufactures with benefit of drawback, 1927 and 1928, by sources, in pounds

Commodity exported	Foreign lead contained in articles exported and products in which the lead was imported									
	In ore		In bullion		In type metal		Pigs, bars, etc.		Total	
	1927	1928	1927	1928	1927	1928	1927	1928	1927	1928
Lead-covered cable.....	-----	-----	-----	-----	-----	-----	1,966,653	245,919	1,966,653	245,919
Tin cans.....	-----	-----	-----	-----	-----	-----	98,682	121,397	98,682	121,397
Lead-headed nails.....	-----	-----	-----	-----	-----	-----	8,033	28,785	8,033	28,785
Lead seals.....	-----	-----	-----	-----	-----	-----	19,043	46,966	19,043	46,966
Lead foil.....	-----	-----	-----	-----	-----	-----	8,225,780	11,620,707	8,225,780	11,620,707
Lead caking.....	32,636	-----	-----	-----	-----	-----	382,386	-----	415,022	-----
Type metal.....	-----	-----	90,823	182,427	-----	-----	-----	532,020	90,823	714,447
Type.....	-----	-----	-----	-----	295,008	-----	-----	-----	295,008	-----
Antimonial lead.....	-----	-----	-----	-----	13,525	-----	203,896	213,999	203,896	227,524
Babbitt.....	-----	-----	-----	-----	-----	-----	198,930	30,183	198,930	30,183
Shot, sheet pipe.....	478,564	217,636	90,730	-----	-----	-----	2,126,374	3,638,790	2,344,010	4,208,084
Shot shells.....	-----	-----	-----	-----	-----	-----	357,853	164,203	357,853	164,203
Lead arsenate.....	-----	14,211	-----	-----	-----	-----	13,327	209,442	13,327	223,653
Red lead, in oil.....	-----	-----	-----	-----	-----	-----	-----	69,196	-----	69,196
Red lead and litharge.....	44,062	-----	160,295	593,690	-----	-----	695,202	908,049	899,559	1,501,739
White lead, dry.....	-----	-----	-----	-----	-----	-----	4,543,472	6,198,038	4,543,472	6,198,038
White lead, in oil.....	38,593	-----	-----	-----	-----	-----	4,290,119	1,048,061	4,328,712	1,048,061
	115,291	492,775	468,754	866,847	295,008	13,525	23,129,750	25,075,755	24,008,803	26,448,902

Domestic and foreign pig lead exported from the United States, 1927 and 1928, by destinations

Destination	Domestic		Foreign	
	Short tons	Value	Short tons	Value
1927				
North America:				
Canada.....	94	\$20,018	26	\$5,250
Cuba.....	55	9,017	147	18,629
Mexico.....	45	9,734	1	93
Panama.....	16	2,898	50	6,730
Other.....	35	5,660	22	2,897
	245	47,327	246	33,599
South America:				
Argentina.....	37	3,408	1,657	173,406
Brazil.....	6	911	2,415	250,483
Chile.....	1,248	141,193	2,285	292,300
Colombia.....	41	7,829	52	7,814
Peru.....	6	843	54	9,316
Uruguay.....	-----	-----	395	45,290
Other.....	16	2,766	282	30,474
	1,354	156,950	7,170	809,083
Europe:				
Belgium.....	-----	-----	1,495	155,438
France.....	-----	-----	7,694	725,860
Germany.....	-----	-----	32,734	3,258,650
Italy.....	-----	-----	336	35,618
Netherlands.....	-----	-----	4,755	459,386
Sweden.....	-----	-----	4,269	428,650
United Kingdom.....	112	14,006	38,222	3,856,461
Other.....	1	287	5,320	573,232
	113	14,293	94,825	9,493,295

*Domestic and foreign pig lead exported from the United States, 1927 and 1928,
by destinations—Continued*

Destination	Domestic		Foreign	
	Short tons	Value	Short tons	Value
1927				
Asia:				
China.....	(¹)	\$45	3,615	\$393,815
Japan.....	561	59,222	16,335	1,712,127
Philippine Islands.....	59	9,155	13	1,142
Other.....	201	21,645	400	46,322
	821	90,067	20,363	2,153,406
Africa.....	(¹)	16	50	4,871
Oceania, including Australia.....	(¹)	45	80	14,312
	2,533	308,698	122,734	12,508,566
1928				
North America:				
Canada.....	132	18,622	(¹)	133
Cuba.....	56	8,363	96	9,986
Mexico.....	37	6,842	42	3,973
Panama.....	17	2,430	2	225
Other.....	42	6,615	48	5,242
	284	42,872	188	19,559
South America:				
Argentina.....	25	3,842	1,218	125,863
Brazil.....	327	30,614	2,112	212,689
Chile.....	222	27,481	272	28,803
Colombia.....	68	9,296	19	2,610
Ecuador.....	11	1,631	7	761
Peru.....	5	578	73	6,730
Uruguay.....	56	5,500	328	30,040
Other.....	88	8,716	3	465
	802	87,658	4,032	407,961
Europe:				
Belgium.....	113	10,111	748	64,438
Denmark.....	116	11,108	3,557	310,592
France.....	399	36,018	4,229	361,105
Germany.....	2,971	262,428	20,581	1,800,853
Italy.....	112	9,860	224	19,580
Netherlands.....	538	48,860	4,550	396,434
Sweden.....	964	85,925	4,352	377,125
United Kingdom.....	7,807	692,314	35,621	3,125,039
Other.....	(¹)	33	279	25,385
	13,020	1,156,657	74,141	6,480,551
Asia:				
China.....			2,131	190,306
Japan.....	2	393	21,214	1,926,751
Philippine Islands.....	49	6,287	161	15,831
Other.....	45	5,055	200	19,241
	96	11,735	23,706	2,152,129
Africa.....	(¹)	57		
Oceania, French.....	(¹)	42		
	14,202	1,299,021	102,067	9,060,200

¹ Less than 1 ton.

CONSUMPTION

APPARENT CONSUMPTION OF REFINED PRIMARY LEAD

Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, 1923-1928, in short tons

	1923	1924	1925	1926	1927	1928
Supply:						
Stock in bonded warehouse Jan. 1-----		2,617	5,045	8,162	10,711	9,464
Imports of pigs, bars, and old ¹ -----	21,099	12,247	7,021	11,152	2,467	662
Production-----	618,322	690,493	766,969	798,941	796,530	781,071
	639,421	705,357	779,035	818,255	809,708	791,197
Withdrawn:						
Exports of foreign lead—						
From warehouse-----	48,736	76,758	98,564	67,660	122,734	102,067
In manufactures, with benefit of drawback-----	12,526	15,275	11,699	17,955	12,004	13,224
Exports of domestic lead-----	1,999	5,332	4,955	4,276	2,533	14,202
Stock in bonded warehouse Dec. 31----	2,617	5,045	8,162	10,711	9,464	4,139
	65,878	102,410	123,380	100,602	146,735	133,632
Apparent consumption-----	573,543	602,947	655,655	717,653	662,973	657,565

¹ Includes 622 tons of "old, reclaimed, and scrap" in 1925 and 1,135 tons in 1926. Corresponding figures for other years not separately recorded.

² Revised figures.

The foregoing table is intended to include only primary lead or lead smelted directly from ore. There are, however, some small discrepancies which should be pointed out. Many primary lead smelters produce from secondary materials some lead which is inseparable from the primary lead in the final product. Exports of lead as reported above may therefore contain some secondary lead. There are also some inaccuracies in the statistics of imports, exports, and warehouse transactions. Nevertheless, on the basis of the data available, the table gives approximately the quantity of new refined lead entering into American industry each year.

The apparent consumption of refined primary lead in 1928 amounted to 657,565 tons, a decrease of 1 per cent from 1927. As the use of lead is intimately associated with the uses of other common metals, and as the apparent consumption of primary copper, zinc, and iron increased 13, 12, and 4 per cent, respectively, it is concluded that the decrease in the consumption of primary lead was due largely to increased use of secondary lead, recovery of which increased 12 per cent in 1928 and was equivalent to 47 per cent of the primary lead consumed.

CONSUMPTION BY USES

The American Bureau of Metal Statistics each year estimates the quantity of lead used by the various industries. The following table is quoted in full from the 1928 yearbook of that bureau.

Lead consumed in the United States,¹ 1920-1928, in short tons

Purpose	1920	1921	1922	1923	1924	1925	1926	1927	1928
White lead ²	116,500	136,000	156,000	130,000	150,000	131,000	120,000	126,000	123,000
Red lead and litharge ³	45,000	23,500	30,000	46,000	34,000	42,000	36,000	38,000	31,000
Storage batteries ⁴	108,000	87,000	130,000	143,000	170,000	180,000	190,000	175,000	220,000
Cable covering ⁴	79,000	67,000	93,000	131,000	138,000	156,000	185,000	161,000	180,000
Building ⁵	71,000	48,000	71,000	75,000	83,100	88,400	93,700	88,000	96,000
Automobiles ⁶	4,750	4,600	7,200	10,400	10,700	12,800	16,700	12,000	17,000
Locomotives ⁶	2,000	1,000	850	2,100	1,100	750	1,000	650	400
Railway cars ⁶	2,800	1,800	2,500	6,000	4,500	4,450	3,800	2,700	2,000
Shipbuilding ⁶	1,550	850	100	100	200	100	100	200	100
Ammunition ⁴	33,600	26,500	38,000	40,000	27,000	31,500	32,000	34,000	39,600
Terneplate ⁴	3,100	3,000	4,700	4,600	4,050	4,500	4,100	3,900	4,400
Foil ⁴	21,000	23,800	26,800	33,300	35,000	32,500	35,000	30,000	35,000
Bearing metal ⁶	26,000	21,000	26,000	28,000	32,000	34,000	36,000	31,000	32,000
Solder ⁷	15,000	12,000	20,000	30,000	30,000	35,000	37,000	35,000	37,000
Type metal ⁷	7,500	7,500	9,500	12,000	13,000	15,000	16,000	16,000	17,000
Calking ⁷	24,000	20,000	20,000	25,000	26,500	30,000	32,000	30,000	32,000
Castings ⁷	15,000	12,000	15,000	15,000	15,000	18,000	18,000	17,000	18,000
Other uses ⁸	20,000	25,000	32,500	36,500	38,000	40,500	44,500	40,500	46,000
Total⁹.....	604,800	520,550	683,150	763,000	812,150	856,500	900,900	840,950	930,500

¹Source: American Bureau of Metal Statistics. These estimates are for the total consumption of lead, irrespective of whether its origin be primary or secondary. Antimonial lead is included and the manufacture of lead for export under drawback provisions is included.

²From data of sales reported by U. S. Geological Survey and U. S. Bureau of Mines, estimating lead content at 80 per cent.

³Based on data of sales reported by U. S. Geological Survey and U. S. Bureau of Mines, estimating lead content of litharge at 92 per cent and red lead at 90 per cent, and from the total deducting the lead estimated as going into storage batteries, this deduction being to eliminate duplication.

⁴Based on reports from a large proportion of manufacturers in each industry, except that manufacturers of ammunition were not requested to report for 1919-1921 and the estimates for those years are conjectural.

⁵Based upon estimates of manufacture and the quantity of lead used per unit of manufacture. Under the head of building is included the lead used in chemical construction and in the chemical industry.

⁶Based on the estimated consumption of lead for this purpose by the railways.

⁷Estimates of persons engaged in the trades.

⁸Conjectural.

⁹These totals are probably slight understatements.

According to the foregoing table the lead consumed by the United States industry in 1928 amounted to 930,500 tons, which surpassed all previous records. It exceeded 1927 by 11 per cent and 1926, the previous peak, by 3 per cent. In the following table the individual uses of lead have been arranged according to their percentage relation to the total lead consumed in 1928.

Percentage of total lead consumed in the United States, 1924-1928, by uses

Use	1924	1925	1926	1927	1928
Storage batteries.....	20.93	21.02	21.09	20.81	23.64
Cable coverings.....	17.00	18.21	20.53	19.15	19.35
White lead.....	18.47	15.29	13.32	14.98	13.22
Building.....	10.23	10.32	10.40	10.46	10.32
Ammunition.....	3.32	3.68	3.55	4.04	4.26
Solder.....	3.69	4.09	4.11	4.16	3.98
Foil.....	4.31	3.80	3.89	3.57	3.76
Bearing metal.....	3.94	3.97	4.00	3.69	3.44
Calking.....	3.26	3.50	3.55	3.57	3.44
Litharge and red lead.....	4.19	4.90	4.00	4.52	3.33
Castings.....	1.85	2.10	2.00	2.02	1.93
Type metal.....	1.60	1.75	1.78	1.90	1.83
Automobiles.....	1.32	1.49	1.85	1.43	1.83
Terneplate.....	.50	.53	.45	.46	.47
Railway cars.....	.55	.52	.42	.52	.21
Locomotives.....	.14	.09	.11	.08	.04
Shipbuilding.....	.02	.01	.01	.02	.01
Miscellaneous.....	4.68	4.73	4.94	4.82	4.94

For several years storage batteries have been the largest consumer of lead, having taken first place from white lead in 1923. Storage batteries are used chiefly in motor vehicles, and the 26 per cent increase in the quantity of lead used in storage batteries in 1928 is in part a reflection of the 28 per cent increase in the number of automobiles and trucks manufactured in that year. Exports of storage batteries have grown steadily from a total of about 207,000 in 1925 to 338,000 in 1928, an increase of 63 per cent. The expansion of the automobile industry and export trade has more than offset the decreased use of storage batteries in radios which resulted from the introduction of "socket power" sets. In 1928 the use of lead in storage batteries exceeded all previous years. The American Bureau of Metal Statistics has estimated that about 15,000,000 storage batteries were manufactured in 1928.

The second largest use of lead is as a protective coating for copper wire cables used chiefly in telephone and underground transmission lines. The quantity of lead so used was 12 per cent greater in 1928 than in 1927 but was slightly less than in 1926. This use appears to be sure to increase. General expansion of the use of electrical power, such as the large electrification programs announced by some of the railway companies and the development of the Boulder Dam and other great power projects, will require large amounts of lead-covered cable. Increasing civic consciousness will undoubtedly result in placing many of the present unsightly overhead transmission lines underground, as has been the custom in Washington, D. C., for many years. Research work now in progress to determine the causes and remedies of certain defects in lead-covered cable that have limited its use in some industries should yield profitable results in expanding the market for lead-covered cable.

The manufacture of white lead is the third largest use of lead, but one that appears to be on the decline. Prior to 1923 this industry was the largest consumer of lead and in 1922 took 156,000 tons of lead, or 23 per cent of the total estimated lead consumption. In 1928 only 123,000 tons (13 per cent of the total) was so used. The declining use of white lead is due to the substitution in paints of the cheaper pigments, principally lithopone and zinc oxide, and to the increased use of nitrocellulose paints in which white lead is seldom used on account of its chemical instability in contact with nitrocellulose products.

During the war lead-tin-cadmium solders containing more lead and less tin than ordinary lead-tin solders were developed and proved economical under the high prices of tin then prevailing. Research has since been continued and several new substitutes have been developed, but owing to the recent increase in the price of cadmium and decrease in the price of tin the advantage of the lead-tin-cadmium solders from a cost standpoint has practically disappeared.

An interesting and comparatively new use of lead is in the manufacture of tetra-ethyl-lead for use in antiknock gasoline. The company making this product estimates that the consumption of this type of gasoline in 1929 will be 1,145,000,000 gallons and that 2,700 tons of

metallic lead will be used. As this quantity represents only 10 per cent of the total gasoline consumed annually in the United States there appears to be room for a substantial increase in the use of lead in this way.

New uses of lead developed in 1928 have been summarized by Metal Industry as follows:¹²

Some uses of lead have occurred during the year which may be considered as new. Molten lead is used in high pressure autoclaves in the Blummer process for making benzine by cracking from benzine free crude oil. The function of the lead is probably to aid in an even distribution of heat and it is said that no real coke formation takes place. A reduction in the noise made by trolley cars was made by partially filling the inside of the gear wheels with lead. Lead-thallium alloys are being used in very small quantities by the General Electric Co., for a fuse metal which gives way at slightly higher temperatures than either lead or thallium. The Westinghouse Electric & Manufacturing Co. is using a new solder for electric motors. It is said to be even better than low tin high lead solders for use at higher temperatures than is possible with ordinary solders. The composition is as follows: Silver, 2½; copper, ¼; lead, 97¼.

PRICES

The two major markets for lead in the United States are at New York and St. Louis, and a large part of the lead produced in the United States is sold at prices based on the quotations in these two markets. The New York quotations are influenced to some extent by the lower prices usually prevailing on the London market, so that the New York price seldom exceeds the St. Louis price by as much as the freight differential, 0.35 cent a pound. The following tables show the average monthly quoted prices of lead at St. Louis, New York, and London for 1926, 1927, and 1928 and the average yearly prices from 1909 to 1928, inclusive.

Average monthly quoted prices of lead at St. Louis, New York, and London, 1926-1928, in cents per pound^a

Month	1926			1927			1928		
	St. Louis	New York	London	St. Louis	New York	London	St. Louis	New York	London
January	9.14	9.35	7.54	7.41	7.58	5.95	6.29	6.50	4.74
February	9.02	9.17	7.36	7.29	7.48	5.92	6.08	6.34	4.41
March	8.19	8.50	6.86	7.34	7.61	6.03	5.82	6.02	4.34
April	7.76	8.04	6.25	6.84	7.11	5.76	6.00	6.11	4.42
May	7.58	7.81	6.13	6.27	6.60	5.43	6.02	6.13	4.46
June	7.90	8.11	6.51	6.16	6.43	5.30	6.16	6.30	4.57
July	8.46	8.63	6.89	6.13	6.36	5.09	6.05	6.22	4.47
August	8.81	8.91	7.10	6.39	6.68	5.02	6.05	6.25	4.68
September	8.52	8.78	6.95	6.05	6.31	4.66	6.29	6.45	4.77
October	8.13	8.40	6.67	6.01	6.26	4.45	6.32	6.50	4.78
November	7.81	8.09	6.34	6.04	6.28	4.55	6.23	6.39	4.60
December	7.69	7.86	6.27	6.33	6.51	4.83	6.34	6.50	4.62

^a St. Louis: Metal Statistics, 1929, p. 391. Average daily quotations of soft Missouri lead, f. o. b. St. Louis (open market), as reported daily in the American Metal Market.

New York: American Metal Market, monthly review section. Pig lead, New York (outside market) prompt shipment from west.

London: Metal Statistics, 1929, p. 395. Average price of foreign lead. Price per long ton, as published in Metal Statistics, converted to cents per pound at average exchange rate reported by the Federal Reserve Board.

¹² Metal Industry, New York, vol. 27, January, 1929, p. 12.

Average yearly prices of lead at St. Louis, New York, and London, 1909-1928

Year	St. Louis ¹ (per pound)	New York ² (per pound)	London ³		New York ex- cess (+) or Lon- don ex- cess (-) (per pound) ⁴
			Per long ton	Per pound	
	Cents	Cents		Cents	Cents
1909.....	4.19	4.30	£13.083	2.84	+1.46
1910.....	4.33	4.49	12.950	2.81	+1.68
1911.....	4.31	4.46	13.463	2.92	+1.54
1912.....	4.38	4.48	17.792	3.87	+ .61
1913.....	4.26	4.40	18.308	3.98	+ .42
1914.....	3.74	3.87	18.688	4.09	- .22
1915.....	4.57	4.67	22.883	4.85	- .18
1916.....	6.80	6.83	30.975	6.58	+ .25
1917.....	8.92	8.71	30.000	6.37	+2.34
1918.....	7.25	7.46	30.133	6.40	+1.06
1919.....	5.55	5.81	28.196	5.57	+ .24
1920.....	7.93	8.08	38.229	6.25	+1.83
1921.....	4.39	4.55	22.725	3.90	+ .65
1922.....	5.52	5.71	23.742	4.69	+1.02
1923.....	7.35	7.25	26.817	5.48	+1.77
1924.....	8.10	8.08	33.696	6.64	+1.44
1925.....	8.92	9.02	35.863	7.73	+1.29
1926.....	8.25	8.42	31.075	6.74	+1.68
1927.....	6.52	6.75	24.192	5.25	+1.50
1928.....	6.14	6.31	21.058	4.58	+1.73

¹ Compiled from daily quotations in the open market at St. Louis, as published in Metal Statistics, 1929, p. 389.

² Average prices based on quotations of American Smelting & Refining Co., as published in Metal Statistics, 1929, p. 383.

³ Prices of foreign lead in London, as published in Metal Statistics, 1929, p. 395, converted to cents per pound on basis of average exchange rates published in the reports of the Federal Reserve Board.

⁴ Import duties on refined pig lead have been as follows: Aug. 6, 1909, to Oct. 3, 1913—2½ cents per pound. Oct. 4, 1913, to Sept. 21, 1922—25 per centum ad valorem; average tariff collected—1½ cents per pound. Sept. 22, 1922, to date (1928)—2½ cents per pound.

To facilitate the settlement of its buying and selling contracts for lead the American Smelting & Refining Co., which controls a large part of the United States lead production, at frequent intervals publishes an official contract price based on the New York market. The following are the company's quotations for 50-ton lots, f. o. b. New York, in 1927 and 1928, in cents per pound.

1927		1927	
Jan. 6.....	7. 65	Aug. 24.....	6. 60
Jan. 20.....	7. 50	Aug. 30.....	6. 50
Jan. 25.....	7. 40	Sept. 6.....	6. 40
Mar. 2.....	7. 55	Sept. 9.....	6. 25
Mar. 3.....	7. 65	Nov. 28.....	6. 30
Mar. 23.....	7. 55	Nov. 29.....	6. 40
Mar. 25.....	7. 45	Dec. 1.....	6. 50
Mar. 29.....	7. 35		
Apr. 4.....	7. 25		
Apr. 18.....	7. 15		
Apr. 20.....	7. 00		
Apr. 28.....	6. 85		
May 2.....	6. 75		
May 16.....	6. 65		
May 19.....	6. 50		
May 26.....	6. 40		
July 1.....	6. 30		
July 7.....	6. 20		
July 20.....	6. 30		
July 21.....	6. 40		
July 22.....	6. 50		
July 29.....	6. 60		
Aug. 3.....	6. 75		
		1928	
		Feb. 10.....	6. 35
		Feb. 20.....	6. 25
		Feb. 27.....	6. 15
		Mar. 1.....	6. 00
		Apr. 2.....	6. 10
		May 25.....	6. 20
		May 29.....	6. 30
		July 9.....	6. 20
		Aug. 23.....	6. 30
		Aug. 27.....	6. 40
		Sept. 17.....	6. 50
		Nov. 9.....	6. 35
		Dec. 3.....	6. 50

The downward trend in the price of lead, which began in the first part of 1925, apparently reached a final low point in March, 1928, and for the balance of that year the trend was definitely upward. The average quotation for January, 1928, was 6.50 cents per pound at New York. By March the monthly average had decreased to 6.02 cents, but the low point in daily quotations was attained during the first part of the month, so that the trend during the greater part of the month was slowly upward. This upward trend was fairly regular thereafter, and in October the monthly average price again reached 6.50 cents, the January quotation. In November there was a slight recession, but in December the average was again 6.50 cents. The opening quotation on January 2, 1928, was 6.50 cents, and the closing quotation on December 31, 1928, was also 6.50 cents.

The average New York price for 1928 was 6.31 cents—7 per cent less than the 1927 average, 30 per cent less than the record 1925 price, and the lowest annual average since 1922. The New York market averaged 0.17 cent per pound over the St. Louis market in 1928, as compared with 0.23 cent in 1927.

The average price, including domestic and foreign sales, received by lead producers in the United States in 1928, according to reports of producers to the Bureau of Mines, was 5.8 cents a pound; in 1927 it was 6.3 cents.

The London quotation reached the low monthly average in March, attained the high for the year in October, declined in November to less than the January average, and failed to recover during December. The yearly average was 13 per cent less in 1928 than in 1927; it was 1.73 cents cent per pound under the New York price in 1928, as compared to 1.50 cents in 1927.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO ¹

(MINE REPORT)

By C. N. GERRY ²

SUMMARY

The value of the mine production of gold, silver, copper, lead, and zinc in Idaho decreased from \$28,104,413 in 1927 to \$26,667,706 in 1928. The decrease was due to the large decline in the output of lead, as the value of all the other metals increased. The quantity of copper decreased 5 per cent, but the value increased as a result of the increase in the average price of the metal from 13.1 cents a pound in 1927 to 14.4 cents a pound in 1928. The total value of the metal output of Idaho in 1928, however, was more than the average annual value for the decade 1919 to 1928, which was \$25,331,756. Since 1863 Idaho has yielded an output of the five metals, as follows: Gold, \$136,648,345; silver, 307,612,976 fine ounces; copper, 149,129,681 pounds; lead, 8,502,311,798 pounds; and zinc, 677,677,672 pounds. The total value has amounted to \$907,402,920, more than half of which represents the value of the lead. The value of the metal output of Idaho from the early days of mining is by no means as large as that of Arizona, California, Colorado, Montana, or Utah, but in 1928 Idaho was third in silver output after Utah and Montana and third in lead output after Missouri and Utah. Dividends for 1928, taken largely from the annual printed reports of the companies but partly estimated, amounted to about \$4,500,000. It is impossible to procure the exact total, as part of the dividend disbursement is paid from operations in other States, and the amount paid by certain lessees is not reported.

Although the metal output of Idaho in 1928 was derived from 21 counties, most of the silver, copper, lead, and zinc was recovered from ore and concentrates from Shoshone County, or the famous Coeur d'Alene region, whose metal output was valued at \$24,792,445, a decrease of \$1,298,828 from that of 1927. Blaine, Custer, Lemhi, and Boise Counties followed in order, but no one of them attained an output valued at as much as \$525,000 in 1928.

Tables printed in Mineral Resources for 1922 and subsequent years give the source of the different metals by kinds of ore and by years from 1911 to 1928. During that period 86 per cent of the gold was derived from placers and from dry and siliceous ore; nearly 75 per cent of the silver and more than 79 per cent of the lead came

¹ Work on manuscript completed February, 1930.

² The valuable assistance of B. N. Lowry and Paul Luff, of the Bureau of Mines, is acknowledged.

from lead ore, and most of the remainder of the silver and lead came from lead-zinc ore and zinc ore. In 1927 and 1928 a large quantity of silver and lead came from copper-lead ore. In 1928, 92 per cent of the gold was derived from placers and from dry gold ore; 51 per cent of the silver and 60 per cent of the lead came from lead ore; nearly all of the remainder of the lead came from lead-zinc ore, and most of the remainder of the silver came from lead-zinc ore and copper-lead ore.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in Idaho, 1919-1928

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919.....	138	72	1,457,395	34,502.89	\$713,238	5,579,056	\$6,248,543
1920.....	114	49	1,958,401	23,490.42	485,590	7,326,794	7,986,205
1921.....	133	92	1,514,447	26,399.73	545,731	6,080,528	6,080,528
1922.....	154	94	1,436,884	24,255.46	501,405	6,081,865	6,081,865
1923.....	146	85	1,763,520	37,124.28	767,427	7,673,662	6,292,403
1924.....	141	79	1,711,988	26,921.80	556,523	7,793,154	5,221,413
1925.....	190	85	1,827,715	20,886.92	431,771	7,743,439	5,373,947
1926.....	177	69	1,934,143	13,669.27	282,569	7,556,444	4,715,221
1927.....	148	70	2,018,325	15,315.67	316,603	8,901,409	5,047,099
1928.....	151	56	2,054,329	20,980.38	433,703	8,998,330	5,264,023

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919.....	3,122,763	\$580,834	182,341,898	\$9,664,121	15,994,229	\$1,167,579	\$18,374,315
1920.....	2,538,396	467,065	249,609,976	19,968,798	27,932,326	2,262,518	31,170,176
1921.....	1,688,195	217,777	198,469,119	8,931,110	33,463	1,673	15,776,819
1922.....	3,282,842	443,184	195,834,205	10,770,881	4,109,131	234,220	18,031,555
1923.....	3,979,631	585,006	242,355,733	16,964,901	27,952,749	1,900,787	26,510,524
1924.....	2,738,824	358,786	248,950,292	19,916,023	15,340,498	997,132	27,049,877
1925.....	3,297,443	468,237	253,041,790	22,014,636	31,237,240	2,374,030	30,662,621
1926.....	1,337,442	187,242	272,980,212	21,838,417	52,614,691	3,946,102	30,969,551
1927.....	2,173,163	284,684	302,038,423	19,028,421	53,556,345	3,427,606	28,104,413
1928.....	2,072,165	298,392	290,645,905	16,857,462	62,526,648	3,814,126	26,667,706

Gold and silver produced at placer mines in Idaho, 1919-1928

Year	Gold		Silver		Year	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value		Fine ounces	Value	Fine ounces	Value
1919 -----	9, 227. 63	\$190, 752	1, 902	\$2, 130	1924 -----	17, 324. 10	\$358, 121	4, 248	\$2, 846
1920 -----	5, 505. 76	113, 814	1, 119	1, 219	1925 -----	12, 692. 92	262, 386	2, 812	1, 952
1921 -----	8, 784. 90	181, 600	1, 686	1, 686	1926 -----	8, 360. 45	172, 826	2, 029	1, 266
1922 -----	8, 899. 64	183, 972	1, 959	1, 959	1927 -----	7, 520. 33	155, 459	2, 306	1, 308
1923 -----	24, 125. 05	498, 709	6, 616	5, 425	1928 -----	8, 191. 63	169, 336	2, 538	1, 485

GOLD

The mine production of gold in Idaho in 1928 was \$433,703, an increase of 37 per cent over 1927 but much less than the average annual output (\$503,456) for the decade 1919 to 1928. The gold output from Idaho was decreasing steadily before 1920, but dredges in Elmore and Shoshone Counties brought up the output in 1923. In 1928 gold from both lode and placer mines increased, especially from the Idawa lode mine. More than 40 per cent of the State's output of gold in 1928 was produced from this property. Lode mines yielded \$264,367 in gold in 1928, an increase of 64 per cent over 1927; placers yielded \$169,336, of which \$133,418 was won by dredges, an increase of \$19,302 over the dredge output in 1927. Since 1897 gold worth \$6,026,932 has been recovered by dredges. Gold from gold ore increased decidedly in 1928, but decreases were recorded from copper ore and lead ore. The production of gold from mills using amalgamation was 8,459.24 ounces, 40 per cent of the total gold output in 1928 and an increase from 3,791.30 ounces in 1927. Concentrates of all kinds yielded nearly 11 per cent of the total gold, crude ore shipped for smelting yielded 10 per cent, and placers yielded 39 per cent.

In 1928 only three mines had a gold output of more than \$24,000 each—those of the Idawa Gold Mining Co., at Placerville; the South Park Dredging Co., at Featherville; and the Idaho Gold Dredging Corporation, at Centerville. Other large producers of gold were the American Gold Dredging Corporation, at Triangle; the Unity Gold Mines Co., at Warren; the Boise Placer Co., at Idaho City; and the Lone Pine mine, at Golden.

SILVER

The mine production of silver in Idaho in 1928 increased slightly and was decidedly more than the yearly average for the decade 1919 to 1928, which was about 7,373,500 ounces. Compared with other large producing States Idaho produced more silver than Arizona or Nevada but less than Utah or Montana. The output of silver in Shoshone County increased 256,922 ounces and there was also a good increase in Blaine County, but the output from Lemhi, Bonner, and Custer Counties was much smaller. The increase in silver was due chiefly to the decided increase in shipments of copper concentrate rich in silver from the Crescent mine in Shoshone County; the Sunshine, Page, Golconda, Dayrock, Triumph, and Sherman mines also made good increases in silver output. The Morning mine, the

largest producer of silver in Idaho in 1925, 1926, and 1927, decreased its output considerably in 1928.

Concentrates yielded 89 per cent of the total silver, crude smelting ore 11 per cent, and placer bullion and gold and silver bullion from lode mines less than one-tenth of 1 per cent.

The Bunker Hill & Sullivan property was the largest producer of silver, followed closely by the Morning and Hecla mines; each of these properties yielded more than 1,600,000 ounces of silver. These three properties and the Sunshine mine produced more than 71 per cent of the State's output of silver. Other large producers of silver were the Gold Hunter, Tamarack & Custer, Crescent, Page, Dayrock (Strattons), Triumph, Callahan Zinc-Lead (Galena), and Sherman mines.

COPPER

The mine production of copper in Idaho in 1928 decreased 5 per cent in quantity from 1927 as a result of the decreased output of the Mackay Metals at Mackay, Custer County, and the Sunshine Mining Co. in Shoshone County. The value of the output, however, increased 5 per cent, as the average price of copper increased from 13.1 cents a pound in 1927 to 14.4 cents in 1928. The output in 1928 was 2,072,165 pounds, or more than 500,000 pounds less than the average yearly output (about 2,623,100) for the decade 1919 to 1928. The production of copper in Custer County decreased from 696,830 pounds in 1927 to 532,400 pounds in 1928 and that in Shoshone County from 1,306,773 to 1,044,105 pounds; but the output in Lemhi County increased from 152,156 to 467,616 pounds. The Winder-Stillman Copper Co., operating the Pope Shenon mine in Lemhi County, increased its output of copper considerably. Concentrates of all kinds yielded 88 per cent of the total copper and crude smelting ore 12 per cent. The largest producers of copper in the State in 1928 were the Mackay Metals at Mackay, Custer County, the Winder-Stillman Copper Co. (Pope Shenon mine) near Salmon, Lemhi County, and the Hecla, Sunshine, and Tamarack & Custer mines in Shoshone County.

LEAD

The mine production of lead in Idaho in 1928 decreased nearly 4 per cent in quantity and more than 11 per cent in value from 1927, as the average price of lead declined from 6.3 cents a pound in 1927 to 5.8 cents in 1928.

The general decrease in lead output was due chiefly to the decrease at the Bunker Hill & Sullivan, United Idaho, Morning, Star, and Galena mines. Good increases, however, were made at the Page, Sherman, Dayrock, Golconda, Gold Hunter, and Triumph mines. Shoshone County supplied nearly 96 per cent of the total lead, and Blaine, Lemhi, Custer, Butte, and Bonner Counties also made good production. Concentrates of all kinds yielded 90 per cent of the total lead, and crude smelting ore 10 per cent.

Ten mines produced more than 3,000,000 pounds of lead each in 1928. Three of them—the Bunker Hill & Sullivan, Morning, and Hecla—yielded more than 56,000,000 pounds each; together they produced more than 72 per cent of the State's output of lead. The other large producers were the Tamarack & Custer, Page, Gold

Hunter, Dayrock, Sherman, Galena (Callahan Zinc-Lead Co.), and Sidney mines.

ZINC

The mine production of zinc in Idaho in 1928 amounted to 62,526,648 pounds, the largest output since 1917 and an increase of nearly 17 per cent over the large output of 1927. The gain was due to the great increase in lead-zinc ore mined at the Morning, Tamarack & Custer, Triumph, Frisco, Page, Golconda, Humming Bird, and Sherman mines. The Morning mine produced more than half of the State's output of zinc. All the zinc concentrates, except those from Blaine, Custer, and Bonner Counties, came from the Coeur d'Alene region, where the largest producers of zinc were the Morning, Tamarack & Custer, Sidney, Frisco, Page, Bunker Hill & Sullivan, Golconda, Humming Bird, and Sherman mines. The Triumph mine, near Hailey, Blaine County, ranked fourth as a producer of zinc in Idaho in 1928; the Livingston mine, near Mackay, Custer County, also produced considerable zinc. Ore that was not milled locally was shipped to custom milling plants at Butte and Anaconda, Mont., and Bauer, Utah. The resulting zinc products were treated at the electrolytic zinc plants at Anaconda and Great Falls, Mont., and at the new electrolytic plant of the Sullivan Mining Co. at Silver King, Idaho.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1928, by counties

County	Gold					Silver (lode and placer)	
	Lode		Placer		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Ada.....	11.47	\$237	4.89	\$101	\$338	78	\$46
Adams.....	2.57	53			53	149	87
Bear Lake.....	.19	4			4	56	33
Blaine.....	163.70	3,384			3,384	149,497	87,456
Boise.....	9,216.06	190,513	2,075.00	42,894	233,407	20,533	12,012
Bonner.....	2.37	49			49	77,210	45,168
Bonneville.....			23.80	492	492	2	1
Boundary.....	3.10	64			64	19,747	11,552
Butte.....	1.26	26			26	33,161	19,399
Camas.....	29.80	616			616	211	123
Clearwater.....			25.23	522	522	7	4
Custer.....	780.28	16,130	19.55	404	16,534	111,555	65,260
Elmore.....	12.92	267	4,503.57	93,097	93,364	1,468	859
Gem.....	276.22	5,710	7.26	150	5,860	4,239	2,480
Idaho.....	1,333.80	27,572	289.04	5,975	33,547	852	498
Lemhi.....	401.31	8,296	296.35	6,126	14,422	61,357	35,894
Owyhee.....	83.11	1,718	778.06	16,084	17,802	4,971	2,908
Shoshone.....	363.68	7,518	63.86	1,320	8,838	8,513,048	4,980,133
Twin Falls.....			1.79	37	37		
Valley.....	106.91	2,210	76.19	1,575	3,785	100	58
Washington.....			27.04	559	559	89	52
Total, 1927.....	12,788.75	264,367	8,191.63	169,336	433,703	8,998,330	5,264,023
	7,795.34	161,144	7,520.33	155,459	316,603	8,901,409	5,047,099

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1928, by counties—Continued

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Ada.....							\$384
Adams.....	13, 245	\$1, 907					2, 047
Bear Lake.....	70	10	29, 754	\$1, 726			1, 773
Blaine.....	3, 377	486	2, 675, 870	155, 200	4, 230, 660	\$258, 070	504, 596
Boise.....	4, 924	709	12, 561	728			246, 856
Bonner.....	2, 282	329	1, 388, 911	80, 557	1, 316	81	126, 184
Bonneville.....							493
Boundary.....	2, 373	342	827, 700	18, 007			59, 965
Butte.....	853	123	2, 163, 525	125, 484			145, 032
Camas.....	621	89					828
Clearwater.....							526
Custer.....	532, 400	76, 666	2, 385, 313	138, 348	965, 001	58, 865	355, 673
Elmore.....							94, 223
Gem.....	269	39	17, 165	996			9, 375
Idaho.....							34, 045
Lemhi.....	467, 616	67, 337	2, 579, 513	149, 612			267, 265
Owyhee.....	30	4	776	45			20, 759
Shoshone.....	1, 044, 105	150, 351	278, 551, 953	16, 156, 013	57, 329, 671	3, 497, 110	21, 792, 445
Twin Falls.....							37
Valley.....							3, 843
Washington.....			12, 864	746			1, 357
Total, 1927.....	2, 072, 165	298, 392	290, 645, 905	16, 857, 162	62, 526, 648	3, 814, 126	26, 667, 706
	2, 173, 163	284, 684	302, 038, 423	19, 028, 421	53, 556, 345	3, 427, 606	28, 104, 413

Ore, old tailings, etc., sold or treated, lode mines producing, and average value of ore, etc., in gold and silver in Idaho, 1927-28, by counties

County	Ore, old tailings, etc. (short tons)		Lode mines producing		Average value per ton in gold and silver	
	1927	1928	1927	1928	1927	1928
Ada.....	172	5	3	3	\$9.81	\$56.40
Adams.....	11	22	1	1	3.36	6.26
Bear Lake.....	20	21	1	1	1.15	1.76
Blaine.....	5, 466	18, 478	11	16	8.91	4.92
Boise.....	6, 662	6, 440	16	10	15.76	31.39
Bonner.....	3, 557	2, 546	7	5	19.24	17.76
Boundary.....	7, 920	6, 335	1	2	1.25	1.83
Butte.....	7, 908	11, 324	2	6	3.14	1.72
Camas.....	14	41	1	1	41.36	18.02
Custer.....	45, 208	42, 478	9	13	2.07	1.92
Elmore.....	55	21	5	2	10.95	12.90
Gem.....	3, 400	1, 639	1	1	5.79	5.00
Idaho.....	650	1, 671	9	8	8.86	16.78
Lemhi.....	17, 056	12, 480	16	24	7.57	3.54
Owyhee.....	344	311	11	12	23.99	14.21
Shoshone.....	1, 919, 309	1, 949, 980	49	42	2.44	2.56
Valley.....	458	516	3	3	4.22	4.36
Washington.....	25	21	2	1	4.24	2.33
	2, 018, 325	2, 054, 329	148	151	2.58	2.69

Production of placer mines in Idaho in 1928, by counties

County	Mines			Gold	Silver (fine ounces)	Total value
	Drift	Dredge	Hydrau- lic and sluicing			
Ada.....			1	\$101	2	\$102
Boise.....	1	1	7	42,894	597	43,243
Bonneville.....			2	492	2	493
Clearwater.....			3	522	7	526
Custer.....			3	404	6	408
Elmore.....		1	2	93,097	1,461	93,952
Gem.....			1	150	2	151
Idaho.....			13	5,975	40	5,998
Lemhi.....			10	6,126	23	6,140
Owyhee.....		1		16,084	352	16,290
Shoshone.....			4	1,320	11	1,326
Twin Falls.....			1	37		37
Valley.....			3	1,575	30	1,593
Washington.....			2	559	5	562
Total, 1927.....	1	3	52	169,336	2,538	170,821
		3	67	155,459	2,306	156,767

MINING INDUSTRY

The general conditions for mining, milling, and smelting of ores in Idaho in 1928 were distinctly favorable for a larger output of the five main metals. The value of the production, however, decreased about \$1,437,000 as a result of the decrease in the average prices of both lead and zinc. The feature of unusual interest affecting the industry in 1928 was the completion and operation of the first unit of the new electrolytic plant of the Sullivan Mining Co. at Silver King near Kellogg. The Bunker Hill & Sullivan Mining & Concentrating Co. not only mines, mills, and smelts silver-lead ores but makes fine gold and silver and pig lead locally. With the completion of the electrolytic plant finished zinc of unusual purity is also made within the State. As a result of intensive development ore reserves increased at the Sunshine mine, on Big Creek; the Morning mine, near Mullan; the Bunker Hill mine, at Kellogg; the Tamarack & Custer and Day-rock properties, north of Wallace; the Golconda mine, east of Wallace; the Sherman mine, at Burke; the Jack Waite mine, near Murray; the Page mine, near Kellogg; the Triumph property, near Hailey; the Whitedelf mine, near Clark Fork; and the Hall Interstate property of the Bunker Hill Co., in Valley County.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in Idaho, 1919-1928, with content in terms of recovered metals

DRY AND SILICEOUS ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	48,251	22,262.08	78,531	11,976	6,455	-----
1920.....	39,811	13,806.37	91,752	50,437	17,540	-----
1921.....	48,221	13,826.54	49,034	7,084	16,942	-----
1922.....	25,766	9,084.94	91,377	19,252	25,995	-----
1923.....	24,059	6,570.14	67,294	5,535	29,719	-----
1924.....	19,260	5,808.43	47,137	1,159	3,086	-----
1925.....	18,135	4,054.53	124,911	51,041	255,762	-----
1926.....	5,862	2,995.17	24,335	3,852	7,495	-----
1927.....	5,268	4,823.28	23,420	3,192	7,902	-----
1928.....	10,571	11,195.84	29,203	5,966	15,162	-----

COPPER ORE

1919.....	51,546	962.13	246,983	2,545,044	-----	-----
1920.....	19,259	1,418.69	52,029	1,733,541	420	-----
1921.....	10,322	1,258.62	23,987	1,105,511	-----	-----
1922.....	32,590	2,045.78	44,550	2,572,335	707	-----
1923.....	41,901	1,516.80	74,247	2,794,091	3,517	-----
1924.....	37,634	2,407.47	504,644	1,989,050	131,204	-----
1925.....	51,004	2,785.20	711,874	2,738,861	33,678	-----
1926.....	28,258	431.64	429,343	586,387	42,512	-----
1927.....	27,742	794.38	49,623	1,030,348	7,000	-----
1928.....	31,454	559.38	262,938	1,058,944	39,833	-----

LEAD ORE

1919.....	1,149,951	1,970.50	4,757,259	564,415	160,572,291	-----
1920.....	1,480,177	2,497.21	6,091,408	657,627	210,039,183	-----
1921.....	1,446,710	2,467.70	5,688,577	449,883	198,322,374	-----
1922.....	1,331,785	2,590.10	5,450,038	399,160	193,551,305	1,699,261
1923.....	1,192,442	2,066.00	5,489,477	594,748	191,685,757	-----
1924.....	1,254,212	1,061.00	5,815,764	672,154	201,074,111	151,453
1925.....	1,088,564	1,048.63	4,791,497	272,978	175,631,005	-----
1926.....	1,084,345	1,455.74	4,575,490	430,937	183,074,616	-----
1927.....	1,308,987	1,828.47	5,609,605	735,175	220,178,217	235,768
1928.....	1,138,581	487.92	4,623,567	443,604	173,763,525	1,427,429

COPPER-LEAD ORE

1919.....	19	0.58	492	1,328	5,604	-----
1920.....	5,015	95.83	225,181	69,791	225,308	-----
1921.....	9,122	61.97	317,244	125,717	129,803	-----
1922.....	26,143	1,635.00	459,529	292,095	333,045	-----
1923.....	52,291	2,587.09	917,215	546,343	1,167,818	-----
1924.....	3,962	12.21	140,423	53,387	536,356	-----
1925.....	6,275	26.31	230,584	90,477	1,233,092	-----
1926.....	22,037	33.98	445,520	116,124	717,352	-----
1927.....	40,125	1.12	1,079,747	264,399	1,316,757	-----
1928.....	49,273	.46	1,146,294	176,210	1,345,312	-----

ZINC ORE, COPPER-LEAD-ZINC ORE, COPPER-ZINC ORE, AND LEAD-ZINC ORE

1919.....	207,628	79.97	493,889	-----	21,757,548	15,994,229
1920.....	414,139	166.56	865,305	22,000	39,327,525	27,932,326
1921.....	72	-----	-----	-----	33,463	-----
1922.....	20,600	-----	34,412	-----	1,923,153	2,409,870
1923.....	452,827	259.20	1,118,813	38,914	49,468,922	27,952,749
1924.....	396,920	308.59	1,280,938	23,074	47,205,535	15,189,045
1925.....	663,737	279.33	1,881,761	144,086	75,908,253	31,237,240
1926.....	793,641	392.29	2,079,727	200,142	89,138,237	52,614,691
1927.....	636,203	348.09	2,136,708	140,049	80,528,457	53,320,577
1928.....	824,450	545.15	2,933,790	387,441	115,482,073	61,099,219

Ore, old tailings, etc., sold or treated in Idaho in 1928, with content in terms of recovered metals

Source	Mines producing	Ore, old tailings, etc.		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore.....	46	¹ 10,304	0.50	11,149.07	53.14	22,002	0.24
Dry gold and silver ore.....	2	201	.01	37.37	.18	2,106	.02
Dry silver ore.....	7	66	-----	9.40	.05	5,095	.06
Copper ore.....	10	31,454	1.53	559.38	2.67	262,938	2.92
Lead ore.....	62	² 1,138,581	55.43	487.92	2.33	4,623,567	51.38
Zinc ore.....	1	³ 450	.02	.50	-----	517	.01
Copper-lead ore.....	2	49,273	2.40	.46	-----	1,146,294	12.74
Copper-lead-zinc ore.....	1	49	-----	.43	-----	123	-----
Lead-zinc ore.....	29	⁴ 823,951	40.11	544.22	2.59	2,933,150	32.60
Total, lode mines.....	⁵ 151	2,054,329	100.00	12,788.75	60.96	8,995,792	99.97
Total, placers.....	56	-----	-----	8,191.63	39.04	2,538	.03
Total, 1927.....	207	2,054,329	100.00	20,980.38	100.00	8,998,330	100.00
	218	2,018,325	-----	15,315.67	-----	8,901,409	-----

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore.....	5,754	0.28	14,243	0.01	-----	-----
Dry gold and silver ore.....	212	.01	919	-----	-----	-----
Dry silver ore.....	1,058,944	51.10	39,833	.01	-----	-----
Copper ore.....	443,604	21.41	173,763,525	59.79	1,427,429	2.28
Lead ore.....	223	.01	6,686	-----	78,661	.13
Zinc ore.....	176,210	8.50	1,345,312	.46	-----	-----
Copper-lead ore.....	1,159	.06	791	-----	2,366	-----
Copper-lead-zinc ore.....	386,059	18.63	115,474,596	39.73	61,018,192	97.59
Lead-zinc ore.....	-----	-----	-----	-----	-----	-----
Total, 1927.....	2,072,165	100.00	290,645,905	100.00	62,526,648	100.00
	2,173,163	-----	302,038,423	-----	53,556,345	-----

¹ Includes 40 tons of old tailings and 11 tons of old cleanings amalgamated and 1 ton of old cleanings sold to a smelter.

² Includes 175,933 tons of old tailings concentrated.

³ Old tailings concentrated.

⁴ Includes 3,146 tons of old tailings concentrated.

⁵ A mine producing more than one class of ore is counted but once in arriving at total for all classes.

Value of metals from ore, old tailings, etc., sold or treated in Idaho in 1928, by kinds of ore

Kind of ore	Ore, old tailings, etc. (short tons)	Gold	Silver	Copper	Lead	Zinc	Total value
Dry gold ore.....	10,304	\$230,472	\$12,871	\$829	\$826	-----	\$244,998
Dry gold and silver ore.....	201	773	1,232	-----	-----	-----	2,005
Dry silver ore.....	66	194	2,980	31	53	-----	3,258
Copper ore.....	31,454	11,563	153,819	152,488	2,310	-----	320,180
Lead ore.....	1,138,581	10,086	2,704,787	63,879	10,078,284	\$87,073	12,944,109
Zinc ore.....	450	10	302	32	388	4,798	5,530
Copper-lead ore.....	49,273	10	670,582	25,374	78,028	-----	773,994
Copper-lead-zinc ore.....	49	9	72	167	46	145	439
Lead-zinc ore.....	823,951	11,250	1,715,893	55,592	6,697,527	3,722,110	12,202,372
Total, 1927.....	2,054,329	264,367	5,262,538	298,392	16,857,462	3,814,126	26,496,885
	2,018,325	161,144	5,045,791	284,684	19,028,421	3,427,606	27,947,646

GOLD ORE

The output of gold ore and old tailings in 1928 was more than double that in 1927. Most of the material—61.6 per cent—was produced from seven mines in the Boise Basin district, Boise County; more than three-fifths of it came from the Belshazzar property, near Placerville, operated by the Idawa Gold Mining Co. The Unity Mines Co., the Rabbit Foot mine, and the Sunnyside Mining & Milling Co. each produced several hundred tons of gold ore. The yield from ore and a small quantity of old tailings was \$22.37 in gold and 2.135 ounces of silver to the ton and a small quantity of copper and lead.

GOLD AND SILVER ORE

Two mines in Owyhee County produced the 201 tons of gold and silver ore; nearly all the ore came from the Neversweat mine near Silver City. The ore yielded \$3.85 in gold and 10.48 ounces of silver to the ton.

SILVER ORE

Small lots of silver ore were mined in 1928 at Arco and Silver City, but most of it came from two properties, one near Grandview, in Owyhee County, and the other near Sandpoint, in Bonner County. The silver ore of the State as a whole yielded \$2.94 in gold and 77.20 ounces of silver to the ton as well as a small quantity of copper and lead.

COPPER ORE

The output of copper ore in 1928 increased more than 13 per cent over 1927, and nearly all of it came from Shoshone, Custer, and Lemhi Counties; most of it—30,144 tons—was concentrated. The output of copper ore from the property of the Mackay Metals in Custer County decreased considerably in 1928, but there was a notable increase in the quantity mined from the Crescent mine in Shoshone County. The Winder-Stillman Copper Co., operating the Pope Shenon property near Salmon, Lemhi County, also produced much more copper ore in 1928 than in 1927. The largest producers of copper ore in Idaho in 1928 were the Crescent, Mackay Metals, and Winder-Stillman properties. The Harmony mine, near Baker, in Lemhi County, also produced several hundred tons of copper ore. The average recovered content of the copper ore shipped or treated in 1928 was 37 cents in gold and 8.36 ounces of silver to the ton, 1.68 per cent of copper, and a little lead.

LEAD ORE

Lead ore has been the most valuable mine product of Idaho since the Coeur d'Alene region became productive. The total output of lead ore and old tailings in 1928 was 13 per cent less than that in 1927, and nearly 81 per cent of it was ore and old tailings of concentrating grade from Shoshone County; operators in Butte, Lemhi, Boundary, and Bonner Counties also mined and shipped much lead ore. The Bunker Hill & Sullivan property, at Kellogg, in Shoshone County, was the leading producer of lead ore, followed by the Hecla mine, at Burke, and the Gold Hunter mine, at Mullan, both also in Shoshone County. The Wilbert mine in Butte County led the mines in the

other counties. Two mines in Idaho produced from lead ore alone nearly 50 per cent of the State's total lead in 1928. The average recovered content of the lead ore and old tailings in 1928 was 4.06 ounces of silver to the ton, 0.02 per cent of copper, 7.63 per cent of lead, and 0.06 per cent of zinc.

COPPER-LEAD ORE

The output of copper-lead ore increased 9,148 tons, or nearly 23 per cent, in 1928, chiefly owing to the fact that the Sunshine (Yankee Boy) property produced more copper-lead ore in 1928 than it did in 1927. The ore in the vicinity of Big Creek consists of galena and tetrahedrite, and as the latter increases the silver and copper are correspondingly increased. Nearly all the copper-lead ore in 1928 was concentrated, and most of it came from Shoshone County; the total output yielded 23.26 ounces of silver to the ton, 0.18 per cent of copper, and 1.365 per cent of lead.

ZINC ORE

No first-class zinc ore was produced in 1928, but old tailings amounting to nearly 500 tons were reconcentrated.

LEAD-ZINC ORE

The output of lead-zinc ore and old tailings in 1928 increased nearly 30 per cent, and all of it was concentrated. The Morning mine in Shoshone County produced nearly half the total; other large producers were the Tamarack & Custer, Page, Sherman, Livingston, Sidney, Frisco, Dayrock, Golconda, and Jack Waite properties, all in Shoshone County except the Livingston, which is in Custer County. The lead-zinc ore and old tailings yielded 3.56 ounces of silver to the ton, 0.02 per cent of copper, 7.01 per cent of lead, and 3.70 per cent of zinc.

Ore, old tailings, etc., sold or treated in Idaho in 1928, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Ada.....	4	11.29	33			
Blaine.....	4	10.07	19	72	46	
Boise.....	6,350	9,203.17	19,795	4,877	8,156	
Boundary.....	2	3.09	2			
Camas.....	41	29.78	211	621		
Custer.....	330	190.10	284			
Elmore.....	21	12.93	7			
Gem.....	20	26.26	479	91	1,000	
Idaho.....	1,671	1,333.83	812			
Lemhi.....	¹ 1,280	166.97	105	93	5,041	
Owyhee.....	² 64	39.24	166			
Shoshone.....	1	15.45	19			
Valley.....	516	106.89	70			
Total, 1927.....	10,304	11,149.07	22,002	5,754	14,243	
	4,389	4,622.17	10,584	2,378	2,940	

¹ Includes 40 tons of old tailings and 6 tons of old cleanings amalgamated and 1 ton of old cleanings sold to a smelter.

² Includes 5 tons of old cleanings amalgamated.

Ore, old tailings, etc., sold or treated in Idaho in 1928, by counties, with content in terms of recovered metals—Continued

DRY SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Ada.....	1	0.20	43	-----	-----	-----
Bonner.....	16	2.30	2,380	170	-----	-----
Butte.....	3	.42	325	12	143	-----
Owyhee.....	46	6.48	2,347	30	776	-----
	66	9.40	5,095	212	919	-----
Total, 1927.....	842	59.54	8,512	648	3,357	-----

COPPER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Adams.....	22	2.57	149	13,245	-----	-----
Bonner.....	13	.06	88	1,774	-----	-----
Custer.....	11,532	495.00	9,776	514,697	-----	-----
Lemhi.....	4,586	60.75	1,447	452,671	-----	-----
Shoshone.....	15,301	1.00	251,478	76,557	39,833	-----
	31,454	559.38	262,938	1,058,944	39,833	-----
Total, 1927.....	27,742	794.38	49,623	1,030,348	7,000	-----

LEAD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Bear Lake.....	21	0.22	56	70	29,754	-----
Blaine.....	301	13.30	13,807	1,679	136,901	-----
Boise.....	90	12.90	141	47	4,405	-----
Bonner.....	2,483	-----	74,461	338	1,387,627	-----
Boundary.....	6,333	-----	19,745	2,373	827,700	-----
Butte.....	11,321	.82	32,836	841	2,163,382	-----
Custer.....	443	7.77	6,887	418	134,402	-----
Gem.....	1,619	249.98	3,758	178	16,165	-----
Lemhi.....	6,614	173.58	59,782	14,852	2,574,472	-----
Shoshone.....	³ 1,109,335	29.35	4,412,010	422,808	166,475,853	1,427,429
Washington.....	21	-----	84	-----	12,864	-----
	1,138,581	487.92	4,623,567	443,604	173,763,525	1,427,429
Total, 1927.....	1,308,987	1,828.47	5,609,605	735,175	220,178,217	235,768

LEAD-ZINC ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
Blaine.....	18,173	140.33	135,671	1,626	2,538,923	4,230,660
Bonner.....	34	-----	281	-----	1,284	1,316
Custer.....	30,057	86.50	73,465	9,051	2,211,796	962,635
Shoshone.....	⁴ 775,687	317.39	2,723,733	375,382	110,722,593	55,823,581
	823,951	544.22	2,933,150	386,059	115,474,596	61,018,192
Total, 1927.....	636,203	348.09	2,136,708	140,049	80,528,457	53,320,577

³ Includes 175,933 tons of old tailings concentrated.

⁴ Includes 3,146 tons of old tailings concentrated.

Zinc concentrates and lead-zinc concentrates (as marketed from Idaho mines and mills) sold to smelters in 1928

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of concentrates	Recovered zinc
Zinc concentrates.....	Blaine, Bonner, Custer, and Shoshone.	<i>Short tons</i> 64,489	<i>Pounds</i> 63,562,583	<i>Per cent</i> 49.28	<i>Pounds</i> 54,669,475
Lead-zinc concentrates...	Shoshone.....	9,964	9,015,680	45.24	7,857,173
		74,453	72,578,263	48.74	62,526,648

METALLURGIC INDUSTRY

In the past much of the ore mined in Idaho was treated by amalgamation or cyanidation, but in 1928 comparatively little ore was treated by these methods. The general tendency seems to be toward concentrating and smelting. About 90 per cent of the total value of the metal output of the State in 1928 was from concentrates, and most of the remainder was from crude smelting ore. Marked progress was made in metallurgy, especially in the treatment of lead-zinc ore by flotation, and several new mills were under construction and others were adding flotation equipment or being changed to regular flotation plants; work at the Morning, Sweeny, Page, Hercules, Galena, Hecla, Jack Waite, and Livingston plants was noteworthy. On account of unusual interest in the relative importance of flotation as a means of concentration, the products of flotation and gravity concentration are given separately except for those mills that make combined flotation and table concentrates. Construction of the Sullivan Mining Co.'s electrolytic zinc-reduction plant at Silver King, near the Bunker Hill smelter, was completed, and operations started late in 1928.

In Idaho 49 milling plants of all kinds were active in 1928, compared with 57 plants in 1927. Of these mills, 31 were concentration plants, 6 of which used flotation machines with other concentrating devices, 21 used flotation alone, and 4 used jigs and tables without flotation cells; 15 used amalgamation alone; and 3 used amalgamation with concentration tables. Besides the milling plants there were two electrolytic leaching plants, one treating zinc concentrates and the other lead concentrates.

In 1928 less than one-half of 1 per cent of the total ore and old tailings, or 10,003 tons of ore and 51 tons of old tailings, was treated in gold and silver mills; the gold and silver recovered were valued at \$176,936, or \$17.60 per ton of material treated. The companies purchased 402 pounds of quicksilver in 1928, an average of 0.04 pound per ton of ore and old tailings amalgamated and 0.034 pound per ounce of gold and silver bullion saved.

Of the total ore and old tailings 97 per cent was concentrated. Metals recovered from the concentrates—from ore concentrated, from 179,529 tons of old tailings re-treated, and from part of the ore treated in gold and silver mills—were valued at \$76.21 to the ton of concentrates, compared with \$76.53 in 1927. The concentrates came largely from the Coeur d'Alene region, where the ratio was 6.4 tons of ore and old tailings to 1 ton of concentrates. The large increase in dry and siliceous concentrates and zinc concentrates offset the decreases in lead concentrates and lead-zinc concentrates. Operators in Shoshone County shipped an average of 24,922 tons of concentrates of various kinds a month, compared with 25,135 tons in 1927. This amount, with the crude ore shipped to smelters (2,943 tons a month), gives the Coeur d'Alene region an average monthly output of 27,865 tons of concentrates and crude ore, compared with 29,684 tons in 1927. The average value of metals recovered from lead concentrates increased from \$78.03 to the ton of concentrates in 1927 to \$83.86 in 1928, but that from zinc concentrates decreased from \$61 to \$58.29, and that from lead-zinc concentrates from \$65.98 to \$61.36. The average value of the copper-lead concentrates

increased considerably, as the concentrates contained much silver; the average value of the copper concentrates also increased considerably.

Of the total ore 2 per cent was shipped crude to smelters at Bradley, Idaho; East Helena and Anaconda, Mont.; Tacoma, Wash.; and plants near Salt Lake City, Utah. The total value of the metals recovered from first-class ore was \$2,313,947, compared with \$3,911,420 in 1927. Of the crude ore shipped to smelters 96 per cent was lead ore; the remainder was largely copper ore. Most of the ore smelted was sulphide, although 12 per cent of the lead ore was carbonate.

The combined value of the metals from concentrates and crude shipping ore was \$26,319,934 in 1928, compared with \$27,868,278 in 1927.

Miscellaneous material other than ore and old tailings milled or ore smelted was insignificant in 1928, and no ore was treated locally by either leaching or roasting methods.

Mine production of metals from gold and silver mills in Idaho in 1928, by counties

County	Ore and old tailings treated (dry weight)		Recovered in bullion			
			Amalgamation		Cyanidation	
	Ore	Old tailings	Gold	Silver	Gold	Silver
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Ada.....	4	-----	11. 29	33	-----	-----
Boise.....	6, 246	-----	6, 681. 91	1, 998	-----	-----
Custer.....	330	-----	190. 10	284	-----	-----
Elmore.....	21	-----	12. 93	7	-----	-----
Idaho.....	1, 664	-----	1, 313. 02	793	-----	-----
Lemhi.....	1, 168	1 46	121. 77	38	-----	-----
Owyhee.....	54	2 5	21. 33	54	1. 47	206
Valley.....	516	-----	106. 89	70	-----	-----
Total, 1927.....	10, 003	51	8, 459. 24	3, 277	1. 47	206
	4, 323	30	3, 791. 30	1, 508	. 20	240

County	Concentrates and recovered metal				
	Concen- trates pro- duced	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Boise.....	679	890. 14	10, 319	4, 170	3, 443
Lemhi.....	6	15. 00	5	-----	4, 350
Total, 1927.....	685	905. 14	10, 324	4, 170	7, 793
	476	640. 91	7, 646	2, 315	1, 224

¹ Includes 6 tons of old cleanings.

² Old mill cleanings.

Idaho ore and old tailings concentrated in 1928, by methods of concentration

Method of concentration	Ore and old tailings concentrated	Concentrates and metal (gross and recovered)		
		Concentrates produced ¹	Gold	Silver
Flotation.....	<i>Short tons</i> 1, 131, 279	<i>Short tons</i> 165, 753	<i>Fine ounces</i> 1, 122. 36	<i>Fine ounces</i> 4, 528, 204
Tables and flotation.....	849, 069	145, 657	147. 23	3, 411, 210
Tables.....	19, 163	2, 899	32. 01	60, 285
	1, 999, 511	314, 309	1, 301. 60	7, 999, 699

Method of concentration	Concentrates and metal (gross and recovered)—Continued					
	Copper		Lead		Zinc	
	Gross	Recovered	Gross	Recovered	Gross	Recovered
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Flotation.....	1, 645, 803	1, 388, 785	125, 234, 985	118, 416, 344	62, 045, 702	53, 590, 065
Tables and flotation.....	661, 202	431, 411	147, 922, 949	140, 431, 336	10, 532, 561	8, 936, 583
Tables.....	4, 162	2, 561	3, 333, 677	3, 166, 994		
	2, 311, 167	1, 822, 757	276, 491, 611	262, 014, 674	72, 578, 263	62, 526, 648

¹ Figures do not include 685 tons from ore first treated by amalgamation or cyanidation containing 905.14 ounces of gold, 10,324 ounces of silver, 6,484 pounds of copper (4,170 pounds recovered), and 8,424 pounds of lead (7,793 pounds recovered).

Mine production of metals from concentrating mills in Idaho in 1928, by counties

County	Ore and old tailings treated		Concentrates and recovered metal					
	Ore	Old tailings	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Blaine.....	18, 173		6, 987	140. 33	135, 671	1, 626	2, 538, 923	4, 230, 660
Boise.....	90		6	12. 90	141	47	4, 405	
Bonner.....	687		115		6, 457		127, 639	1, 316
Boundary.....	6, 190		619		17, 026	1, 921	685, 212	
Butte.....	11, 280		1, 881	20	31, 169	151	2, 146, 724	
Custer.....	40, 575		4, 378	494. 34	82, 949	441, 145	2, 244, 817	965, 001
Gem.....	1, 619		132	249. 98	3, 758	178	16, 165	
Lemhi.....	5, 998		1, 120	26. 06	10, 069	436, 292	298, 423	
Owyhee.....	240		10	34. 97	3, 312	30	776	
Shoshone.....	1, 735, 130	179, 529	299, 061	342. 82	7, 709, 147	941, 367	253, 951, 590	57, 329, 671
Total, 1927.....	1, 819, 982	179, 529	314, 309	1, 301. 60	7, 999, 699	1, 822, 757	262, 014, 674	62, 526, 648
	1, 767, 391	172, 819	312, 571	2, 219. 69	7, 452, 078	1, 860, 303	253, 926, 036	53, 541, 245

Gross metal content of Idaho concentrates produced in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
		<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	<i>Short tons</i> 16, 239	927. 57	54, 959	23, 230	1, 430, 410	-----
Copper.....	2, 475	414. 56	258, 552	997, 472	41, 929	-----
Lead.....	219, 987	550. 81	6, 234, 121	774, 851	267, 006, 243	-----
Zinc.....	64, 489	282. 10	280, 565	211, 928	4, 675, 583	63, 562, 583
Copper-lead.....	1, 840	. 40	1, 125, 394	283, 157	1, 376, 561	-----
Lead-zinc.....	9, 964	31. 30	56, 432	27, 013	1, 969, 309	9, 015, 680
	314, 994	2, 206. 74	8, 010, 023	2, 317, 651	276, 500, 035	72, 578, 263

Mine production of metals from Idaho concentrates in 1928

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Blaine.....	6, 987	140. 33	135, 671	1, 626	2, 538, 923	4, 230, 660
Boise.....	685	903. 04	10, 460	4, 217	7, 848	-----
Bonner.....	115	-----	6, 457	-----	127, 639	1, 316
Boundary.....	619	-----	17, 026	1, 921	685, 212	-----
Butte.....	1, 881	. 20	31, 169	151	2, 146, 724	-----
Custer.....	4, 378	494. 34	82, 949	441, 145	2, 244, 817	965, 001
Gem.....	132	249. 98	3, 758	178	16, 165	-----
Lemhi.....	1, 126	41. 06	10, 074	436, 292	302, 773	-----
Owyhee.....	10	34. 97	3, 312	30	776	-----
Shoshone.....	299, 061	342. 82	7, 709, 147	941, 367	253, 951, 590	57, 329, 671
	314, 994	2, 206. 74	8, 010, 023	1, 823, 927	262, 022, 467	62, 526, 648
Total, 1927.....	313, 047	2, 860. 60	7, 459, 724	1, 862, 618	253, 927, 260	53, 541, 245

BY KINDS OF CONCENTRATES

Dry and siliceous.....	16, 239	927. 57	54, 959	14, 238	1, 358, 890	-----
Copper.....	2, 475	414. 56	258, 552	938, 799	39, 833	-----
Lead.....	219, 987	550. 81	6, 234, 121	513, 525	253, 703, 819	-----
Zinc.....	64, 489	282. 10	280, 565	168, 400	3, 970, 207	54, 669, 475
Copper-lead.....	1, 840	. 40	1, 125, 394	169, 958	1, 307, 733	-----
Lead-zinc.....	9, 964	31. 30	56, 432	22, 007	1, 641, 985	7, 857, 173

Gross metal content of Idaho crude ore shipped to smelters in 1928

Class of ore	Quantity (dry weight)	Gross metal content			
		Gold	Silver	Copper	Lead
		<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	<i>Short tons</i> 273	1, 791. 85	12, 074	2, 314	7, 887
Copper.....	1, 310	144. 82	4, 386	124, 081	-----
Lead.....	43, 113	183. 46	944, 812	191, 125	30, 082, 651
Copper-lead.....	67	. 47	21, 014	10, 884	40, 341
	44, 763	2, 120. 60	982, 286	328, 384	30, 130, 879

Mine production of metals from Idaho crude ore shipped to smelters in 1928

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Ada.....	1	0.20	43	-----	-----	-----
Adams.....	22	2.57	149	13,245	-----	-----
Bear Lake.....	21	.22	56	70	29,754	-----
Blaine.....	305	23.37	13,826	1,751	136,947	-----
Boise.....	104	1,631.12	7,478	707	4,713	-----
Bonner.....	1,859	2.36	70,753	2,282	1,261,272	-----
Boundary.....	145	3.09	2,721	452	142,488	-----
Butte.....	44	1.04	1,992	702	16,801	-----
Camas.....	41	29.78	211	621	-----	-----
Custer.....	1,573	95.83	28,316	91,255	140,496	-----
Gem.....	20	26.26	479	91	1,000	-----
Idaho.....	7	20.81	19	-----	-----	-----
Lemhi.....	5,267	237.76	51,222	31,324	2,276,740	-----
Owyhee.....	12	25.32	1,047	-----	-----	-----
Shoshone.....	35,321	20.87	803,890	102,738	24,600,363	-----
Washington.....	21	-----	84	-----	12,864	-----
Total, 1927.....	44,763	2,120.60	982,286	245,238	28,623,438	-----
	73,762	1,143.20	1,437,631	310,545	48,111,163	15,100

BY KINDS OF ORE

Dry and siliceous.....	273	1,791.85	12,074	1,711	6,592	-----
Copper.....	1,310	144.82	4,386	120,145	-----	-----
Lead.....	43,113	183.46	944,812	116,307	28,578,521	-----
Copper-lead.....	67	.47	21,014	7,075	38,324	-----

REVIEW BY COUNTIES AND DISTRICTS

As the detailed review of the districts was omitted from the report of this series for 1927, the production of the important districts for that year has been inserted in the following review.

The report ³ of the mine inspector of Idaho contains notes on the progress of the mining industry, lists the active companies, and gives an interesting bibliography for each county.

ADA COUNTY

Black Hornet district.—A little gold bullion, which was probably a clean-up from the McCarty group, was marketed, and several properties such as the Gold King, Sorrel Horse, Idaho, and Reliance were being developed.

ADAMS COUNTY

Seven Devils district.—One car of oxidized copper ore was shipped from the Blue Jacket claim near Cuprum, and development was continued at the Lime Peak and National Copper properties. In 1927 considerable development was done and equipment installed at the Red Ledge group of the Idaho Copper Co., but no further work was accomplished in 1928 on this large low-grade deposit as the company was involved in litigation.

³ Campbell, Stewart, Thirtieth Annual Report of the Mining Industry of Idaho, for 1928.

BEAR LAKE COUNTY

St. Charles district.—The Sunset Mining Co. spent \$2,000 in developing claims near St. Charles and shipped one car of sulphide lead ore to the smelter at Midvale, Utah.

Unorganized (Paris) district.—Several properties near Paris were being developed in 1928; the main one was the Boulder group of the Utah-Idaho Mining & Milling Co.

BLAINE COUNTY

The value of the mine production of metals in Blaine County increased from \$200,337 in 1927 to \$504,596 in 1928, entirely the result of the large increase in the shipments of lead-zinc ore from the Triumph mine, which adjoins the North Star property of the Federal Mining & Smelting Co. From 1880 to 1928 Blaine County has produced \$2,568,613 in gold, \$16,502,335 in silver, \$67,292 in copper, \$9,229,405 in lead, and \$992,387 in zinc, a total of \$29,360,032. The quantities of the various metals follow: Gold, 124,258.40 fine ounces; silver, 18,175,150 fine ounces; copper, 388,752 pounds; lead, 204,679,950 pounds; and zinc, 13,563,839 pounds. In 1928 the value of the mine production was larger than that of any other county in the State except Shoshone.

Mineral Hill district (Hailey).—In 1928 nine lode mines in the Mineral Hill district produced 80 tons of ore, yielding \$230 in gold, 5,359 ounces of silver, 871 pounds of copper, and 62,480 pounds of lead, valued in all at \$7,114, or \$88.93 in metals a ton. In 1927 seven lode mines produced 177 tons of ore, yielding \$31 in gold, 11,761 ounces of silver, 751 pounds of copper, 150,391 pounds of lead, and 1,692 pounds of zinc, valued in all at \$16,380, or \$92.54 in metals a ton. The output in 1928 consisted chiefly of sulphide lead ore shipped directly to a smelter. A car of lead ore each was shipped from the Eureka and Star mines, and small lots of similar material were shipped from the Idaho Democrat, Hillside & Sidehill, Minnie Moore, Richmond, Ivanhoe, and Big Joint claims. A small quantity of gold concentrates, probably a clean-up from former work, was shipped by the Daisy Mining & Milling Co., operating the Camas group near Hailey.

Warm Springs district (Ketchum).—Seven lode mines in the Warm Springs district produced 18,398 tons of ore, yielding \$3,154 in gold, 144,138 ounces of silver, 2,506 pounds of copper, 2,613,390 pounds of lead, and 4,230,660 pounds of zinc, valued in all at \$497,482, or \$27.04 in metals a ton. Of this output 225 tons was first-class lead ore shipped to a smelter and 18,173 tons was lead-zinc ore of milling grade, which yielded 6,987 tons of concentrates. In 1927 four lode mines produced 5,289 tons of ore, yielding \$1,377 in gold, 71,631 ounces of silver, 2,365 pounds of copper, 955,516 pounds of lead, and 1,272,775 pounds of zinc, valued in all at \$183,957, or \$34.78 in metals a ton. Most of the output in both 1927 and 1928 was lead-zinc ore from the Triumph property treated at a custom mill in Utah. In 1928 the mine produced more than 17,000 tons of ore consisting chiefly of sphalerite and galena, which was shipped to the flotation plant of the Combined Metals Reduction Co. at Bauer, Utah, where it was separated into lead concentrates and zinc concentrates. The mine

ranked fourth as a producer of zinc in Idaho in 1928, tenth as a producer of silver, and thirteenth as a producer of lead; excluding the Coeur d'Alene region, it was the largest producer of lead in Idaho. The company completed surveys and plans for the construction of an aerial tramway 4 miles long and a modern flotation mill near Gimlet, the shipping point on the Oregon Short Line Railroad. Lessees operating the North Star property of the Federal Mining & Smelting Co. shipped several cars of lead-zinc ore to the flotation mill at Midvale, Utah. Lessees also operated the Independence mine of the Federal Mining & Smelting Co. and shipped a few cars of first-class sulphide lead ore for smelting. The Hailey Bonanza Mining Co. worked its property on a small scale throughout the year and shipped four cars of lead ore to the Midvale smelter. The property is equipped with a 150-ton concentrating mill including jigs and tables; the mill was not operated in 1928. Small lots of lead ore were also shipped from the Big Chief, Chloride Point, and Silver Cord claims.

BOISE COUNTY

The value of the mine production of metals in Boise County increased from \$171,670 in 1927 to \$246,856 in 1928 as a result of the increased production of siliceous gold ore from the Belshazzar mine of the Idawa Gold Mining Co., which became the largest producer of gold in Idaho. The placer production was valued at \$43,243, a decrease of \$14,387 from that of 1927. The output of the dredge at Centerville, operated by the Idaho Gold Dredging Corporation, was less than that of 1927.

Banner district.—A small test lot of gold ore from the Choowathoo mine was treated by amalgamation and the bullion sent to the assay office at Boise. The Edna Mines Co. (Inc.), owner of the Edna mine near Idaho City, spent most of the year in retimbering the mine and repairing 2,300 feet of track between the mine and the mill. The mine is developed by an 800-foot adit tunnel to a winze 145 feet deep. The 50-ton cyanidation plant on the property was practically idle as only experimental tests were made. In 1927 the Crooked River Mining Co. constructed a dredge equipped with 65 buckets and driven by two Diesel engines. The plant was said to have cost \$92,000, but it was improperly constructed and was never operated. During 1928 \$60,000 was reported spent in reconstructing it but no production was made.

Boise Basin district (Centerville, Placerville, Idaho City, Pioneer-ville).—In 1928 eight placers and eight lode mines in the Boise Basin district produced 6,433 tons of ore, \$230,663 in gold, 20,494 ounces of silver, 4,924 pounds of copper, and 12,561 pounds of lead, valued in all at \$244,089. The ore had an average value of \$31.56 in metals a ton. The placer output consisted of \$40,746 in gold and 570 ounces of silver, valued together at \$41,079. In 1927, 15 placers and 12 lode mines produced 6,623 tons of ore, \$149,755 in gold, 17,886 ounces of silver, 3,969 pounds of copper, and 135,626 pounds of lead, valued in all at \$168,962. The ore had an average value of \$17.10 in metals a ton, and the placer output was valued at \$55,704. In both 1927 and 1928 the greater part of the gold was produced from the Belshazzar mine at Placerville, operated by the Idawa Gold Mining Co. The ore, which contains gold, pyrite, arsenopyrite, and

bismuthinite, was treated in a 30-ton mill equipped with amalgamation plates and Wilfley tables. Gold bullion valued at about \$133,000 was sent to the Boise assay office in 1928, and several hundred tons of concentrates containing gold and silver was shipped to a smelter in Utah. Some of the ore opened in 1928 was so rich that it was shipped directly to the assay office without previous treatment. In 1927 the property was second to the South Park dredge, at Featherville, in production of gold, and in 1928 it became the largest producer of gold in Idaho. An initial dividend of \$56,000 was paid in 1928. Development consisted of 728 feet of tunneling. The Come Back mine produced 86 tons of ore containing 404.38 ounces of gold and 6,884 ounces of silver. Development in 1928 consisted of 450 feet of drifts, crosscuts, and upraises. Gold ore from the Hay Fork, Lillian, and Esperence properties was treated by amalgamation, and the bullion was sent to the assay office at Boise. A small quantity of lead concentrates, cleaned up from former operations, was shipped by the Mineral Mining Co. The Gold Hill & Iowa property, formerly a large gold producer, was taken over in March, 1927, by the Talache Mines (Inc.). Since then considerable money has been spent in unwatering and developing the mine. The shaft was deepened to the 700-foot level, and 3,300 feet of work was done, chiefly in drifting. Early in 1929 an amalgamation mill was reconstructed using parts of the old Gold Hill & Iowa mill and parts of the Talache mill in Bonner County. In July, 1928, the Federated Mines Co. took control of the Mountain Chief, Banner King, and Hanley groups, installed new mine and mill machinery, repaired the tramway, built and repaired roads, did 500 feet of development, and installed a new amalgamation, concentration, and flotation mill. Further expansion was planned for 1929 when the mill was operated. The largest placer production of the district in 1928 was that of the Idaho Gold Dredging Corporation, formerly the Gold Dredging & Power Corporation. The corporation operated an electric dredge on Grimes Creek above Centerville from March 13 to December 1 and ranked third as a producer of gold in Idaho. The dredge is equipped with 80 buckets and has a capacity of 2,000 cubic yards a day; in 1928 it treated about 293,715 cubic yards of gravel. The largest production of gold by hydraulicking was that of the Boise Placer Co., which operated the Plowman, Woodburn, Mann, and Hansen groups adjoining Idaho City on the northwest. The company operated from April 1 to July 1 and handled 216,360 cubic yards of gravel. The property is equipped with six giants and machinery for breaking boulders too large to go through the sluice boxes. Gold was also recovered at the National Hydraulic (Gold Eagle), Black Hawk, Halley, and Napper placer properties, and surface material at the Gold Hill mine yielded considerable gold by placer operations.

Payette River district.—Placer gold was recovered from the Jackson Bar property on the north fork of Payette River, 4 miles from Banks.

Summit Flat district.—A small quantity of gold ore from the Mademoiselle property was treated by amalgamation.

BONNER COUNTY

The value of the mine production of metals in Bonner County decreased \$74,955 in 1928, as the quantity of lead and silver decreased considerably. The largest producer in the county was the

Whitedelf Mining & Development Co., operating a silver-lead property near Clark Fork, but shipments in 1928 were curtailed.

Clark Fork district.—A small quantity of sulphide copper ore was shipped from the Copper King mine near Clark Fork. The ore was hauled to Woodlin, Mont., a station on the Northern Pacific Railroad.

Lakeview district.—Two cars of lead-zinc ore from the Minerva dump on Minerva Mountain, near Falls Creek, were shipped by a lessee to the Hercules custom mill. The Minerva mine is being put in condition for production after being idle for 15 years. The Idaho Lakeview Mines Co. purchased the Hewer mine in October, installed a new hoist, and enlarged the shaft with a view to sinking it to a depth of 1,200 feet.

Pend d'Oreille district.—In 1928 three lode mines in the Pend d'Oreille district produced 2,499 tons of ore, yielding \$48 in gold, 76,841 ounces of silver, 508 pounds of copper, and 1,387,627 pounds of lead, valued in all at \$125,555, or \$50.24 in metals a ton. All of the output except 653 tons of lead ore that was concentrated was first-class silver-lead ore. In 1927 six lode mines produced 3,057 tons of ore, yielding \$16 in gold, 118,611 ounces of silver, 2,854 pounds of copper, and 2,096,460 pounds of lead, valued in all at \$199,720, or \$65.33 in metals a ton. The largest production in 1927 and 1928 was that of the Whitedelf Mining & Development Co., operating property near Clark Fork. In 1928 more than 1,600 tons of sulphide lead ore containing considerable silver was shipped to East Helena, Mont., and Kellogg, Idaho, and a few hundred tons of milling ore was treated in a custom flotation plant in Idaho. Development in 1928 consisted of 1,000 feet of drifting, and plans were drawn for a 75-ton flotation plant. The Hope Mining Co., owning the Elsie K. property, shipped nearly 200 tons of first-class silver-lead ore to East Helena, Mont., and 178 tons of low-grade lead ore to a custom flotation mill in Idaho. More than 1,500 feet of tunnel work, which was said to have opened a large quantity of new ore, was done in 1928. A car of ore rich in silver was shipped from the Catherine property near Sagle, on Blacktail Mountain. Development was continued at the Lawrence mine, under new management, and prospecting and road building were done at the Regal claims, a new property.

BONNEVILLE COUNTY

Mount Pisgah district.—Exceptionally rich placer gold was recovered from the American and Milwaukee claims on Caribou Mountain, northeast of Gray.

BOUNDARY COUNTY

The value of the mine production of metals in Boundary County declined \$8,814 in 1928, although the output of all metals except lead increased. The large decrease in the output of lead was caused by the decline in the shipments of lead concentrates from the mill of the Idaho Continental Co.

Moyie Yahk district (Bonners Ferry).—A small test lot of gold ore was shipped from the Boulder Creek property near Bonners Ferry.

Port Hill district (Klockmann).—The Idaho-Continental mine was operated in 1928 on a part-time basis and produced about 600 tons of silver-lead concentrates and 143 tons of crude silver-lead ore, which

were shipped to the Bunker Hill smelter at Bradley. The output was considerably less in 1927 and 1928 than it has been in recent years.

BUTTE COUNTY

The mine production of metals in Butte County in 1928 was valued at \$145,032, a decrease of \$28,864 from 1927. The output of ore increased considerably, but the quantity of all metals, particularly lead, decreased. The Wilbert mine near Howe was the largest producer in the county, but the quantity of lead concentrates marketed was less.

Dome district.—The mine and mill of the Wilbert Mining Co. (Ltd.) were operated continuously in 1928, and 800 feet of development was done. The mine has become an important producer, and in 1928 the output contained more than 2,000,000 pounds of lead. A 60-ton concentration mill equipped with jigs and tables treated more than 11,000 tons of lead ore, which was reduced to 1,839 tons of lead concentrates. The output was shipped from Arco, a station on the Oregon Short Line Railroad, to the smelter at Midvale, Utah. A small test lot of lead ore was shipped from the Regan mine near Howe.

Lava Creek district.—Four lode mines in the Lava Creek district produced 41 tons of ore, yielding \$21 in gold, 1,875 ounces of silver, 688 pounds of copper, and 15,053 pounds of lead, valued in all at \$2,090, or \$50.98 in metals a ton. Most of the output was first-class lead ore shipped from the St. Louis and Silver Bell properties. Development of the Silver Bell mine was directed by the Federal Mining & Smelting Co. under lease. A small lot of ore rich in silver from the Pandora property and a small lot of lead ore from the Pine Tree claim were shipped to the lead smelter at Midvale, Utah.

CAMAS COUNTY

Beaver Creek (Mineral Hill) district.—In the course of development work the Consolidated Mines Syndicate shipped one test car of siliceous gold ore from the Princess-Blue Ribbon property, near Fairfield. It was reported that a large body of commercial ore had been opened on the 200-foot level.

CLEARWATER COUNTY

Moose Creek district.—Gold bullion was recovered from the Poorman placer on Independence Creek, in Moose Basin, 42 miles from Rivulet, Mont.

Pierce district.—The placer output of the Pierce district was valued at \$266, a marked decrease from the production of 1917, when the Bailey dredge was operated. No ore was shipped from the district in 1928, although the new branch line of the railroad from Orofino to Pierce was completed and operated in 1927.

CUSTER COUNTY

The value of the mine production of metals in Custer County decreased from \$403,270 in 1927 to \$355,673 in 1928. The decrease in the output of lead more than offset the large increase in the output

of zinc. There was also a decrease in the output of gold, silver, and copper. The Livingston Mines Corporation, an important producer of silver and lead since 1924, became a producer of zinc as a result of shipping lead-zinc middlings to a custom flotation plant.

Alder Creek district (Mackay).—In 1928 six lode mines in the Alder Creek district produced 11,904 tons of ore, yielding \$10,327 in gold, 11,842 ounces of silver, 516,216 pounds of copper, 94,243 pounds of lead, and 5,477 pounds of zinc, valued in all at \$97,390, or \$8.18 in metals a ton. In 1927 three lode mines produced ore yielding gold, silver, copper, lead, and zinc valued at \$118,160, or \$8.53 in metals a ton. The output in 1928 consisted of 1,463 tons of first-class ore and of 10,441 tons of milling ore, which was reduced to 1,064 tons of concentrates. The largest producer in both 1927 and 1928 was the Empire mine, of the Mackay Metals, formerly operated by the Idaho Metals Co. The mine was idle and in the hands of a receiver until June, when the new company was organized and development and milling were resumed. In 1928 the 250-ton flotation mill treated more than 9,000 tons of copper ore, and the resulting concentrates were shipped to International, Utah, for smelting. The company also shipped more than 1,000 tons of first-class oxidized copper ore. The total output, however, was considerably less than that of 1927. The mine is opened by more than 20 miles of drifts and tunnels, and 1,500 feet of development was done in 1928. The property has been the largest producer of copper in Idaho since the output of the Snow Storm mine in Shoshone County declined. A lessee on the Blue Bird mine near White Knob shipped a few hundred tons of sulphide lead ore of smelting grade and one car of lead-zinc ore was shipped to the custom flotation mill at Midvale, Utah. The White Knob property of the United States Smelting, Refining & Mining Co. produced one car of oxidized lead ore, and the Kay Development Co., operating the Horseshoe mine, shipped one car of copper-lead-zinc mill ore to a custom flotation plant. Small lots of sulphide lead ore were shipped from the Black Daisy and Cameron properties.

Alto district.—A car of lead-zinc mill ore was shipped from the Black Rock mine at the head of Big Lost River to a custom flotation plant.

Bay Horse district.—Lessees operating the Ramshorn mine shipped two cars of sulphide copper-lead ore exceedingly rich in silver. The mine produced a large quantity of silver, copper, and lead from 1920 to 1925 but has not been vigorously worked since that time. The 50-ton concentration plant was idle. The Clark Mining Co., working the Camp Bird property near Clayton, shipped three cars of lead ore to the International concentration plant at Tooele, Utah, and the Twin Apex Mines Co. continued development by drifting about 800 feet.

Boulder district.—The Livingston Mines Corporation conducted the largest milling operations in southern Idaho and shipped concentrates, which yielded a large production of silver, lead, and zinc. The 300-ton concentration plant, equipped with tables and flotation cells, treated about 25,000 tons of lead-zinc ore. The company, however, does not make high-grade zinc concentrates but ships lead concentrates, which are smelted, and lead-zinc middlings, which are re-treated at the flotation plant at Midvale, Utah. The output of lead was less than that of 1927, but there was a good increase in zinc.

Considerable work was done in drifts, raises, and crosscuts in 1928 to develop ore containing galena, sphalerite, jamesonite, pyrite, and arsenopyrite. The property is 75 miles from the shipping point at Mackay, and considerable money has been spent in the upkeep of the roads and in purchasing trucks to haul the concentrates. Crater Mines (Inc.) is developing a group of 39 claims at the head of Livingston Gulch.

Seafoam district.—The Seafoam Mines Corporation operated a 50-ton amalgamation and concentration plant a few months in 1928 and shipped gold bullion to the assay office at Boise, but no concentrates were marketed. The property was operated until July, when all work was stopped on account of financial difficulties. A car of oxidized lead ore containing considerable silver was shipped from the Greyhound mine to the lead smelter at Midvale, Utah. The ore is hauled 100 miles to Ketchum, a station on the Oregon Short Line Railroad.

Stanley Basin district.—A little placer gold was recovered from Jose Gulch and Kelly Gulch.

Yankee Fork district.—The Snowdrift mine near Stanley produced a few hundred tons of gold ore which, after amalgamation, yielded bullion valued at nearly \$2,000. The Rough Creek placer near Clayton was operated two months and produced gold bullion which was sent to the mint at Denver.

ELMORE COUNTY

Dredge operations near Featherville in 1928 resulted in a large production of gold bullion, which increased the total value of the metal output for the county \$13,136.

Bear Creek district (Featherville).—The large electric dredge of the South Park Dredging Co., at Featherville, equipped with sixty-seven 9-cubic-foot buckets, was operated from January 1 to June 14, after which work was temporarily suspended. The plant has a capacity of 5,000 cubic yards per day, and 622,736 cubic yards of material was handled in 1928. The property ranked second as a producer of gold in Idaho in 1928; it ranked first in 1926 and 1927.

Black Warrior district.—The La Trinidad Mining Co. operated the Black Warrior placer property near Atlanta and produced a small quantity of gold bullion, which was deposited at the assay office at Boise. Considerable work was done in testing the ground and hauling pipe. The stockholders of the La Trinidad Mining Co. organized the Black Warrior Mines (Inc.) to absorb and operate the former company's holdings.

Middle Boise district (Atlanta).—A small quantity of gold was recovered by amalgamation at the Winner group near Atlanta. Considerable work was done in constructing a mill building, a high-line ditch was dug in order to do away with the pumping station, and a concentration table was added to the mill equipment.

Pine Grove district.—A 5-stamp amalgamation mill was run on gold ore from the Objective mine near Pine, and a little bullion was sold to the assay office at Boise.

Twin Springs district.—A little placer gold was recovered from the Sunflower property.

GEM COUNTY

West View district.—The Lincoln mine, a large producer of gold and silver from 1904 to 1909, was worked in 1928 by the Lincoln Mine Operating Co. The company treated more than 1,600 tons of ore in a 100-ton flotation plant and shipped concentrates to Utah containing about 2 ounces of gold and 35 ounces of silver to the ton and 6.5 per cent of lead. One car of first-class siliceous gold ore was also shipped for smelting. A small quantity of gold bullion was recovered from the Blue Bell placer 8 miles northeast of Emmett.

IDAHO COUNTY

The mine production of metals in Idaho County was valued at \$34,045 in 1928, an increase of \$20,107 over 1927 but a small output compared with that of 20 years ago. The Unity Gold Mines Co. at Warren and the Lone Pine mine at Golden were the largest producers in the county.

Butts Creek district.—A little placer gold from the Wild Rose claim was recovered by hydraulic mining.

Elk City district.—Four placers and two lode mines in the Elk City district produced 15 tons of ore, \$1,037 in gold and 28 ounces of silver, valued together at \$1,053. The Idaho-Nevada Consolidated Gold Mines Co. was organized to operate the Black Pine and Diamond groups, and a test lot of siliceous gold ore was shipped to Bradley for smelting. A small quantity of gold ore from a property near Elk City was treated by amalgamation, and the bullion was sent to the mint at San Francisco, Calif. Small quantities of placer gold were recovered from the Deadwood, Erickson, Stewart, and Johnson claims.

Florence district.—No output was reported in the Florence district except a small quantity of placer bullion produced from the Black Sand property near Grangeville.

Marshall Lake district.—The Leadville group near Burgdorf, which is being developed, produced 31 tons of gold ore which was treated in a 2-stamp amalgamation mill. A small quantity of rich gold ore from the Cuban property was treated in a hand mortar; the bullion was sent to the assay office at Seattle, Wash.

Simpson district.—The Butcher Bar, Dandy, and Mountain Queen groups, comprising 120 acres of placer claims 42 miles southeast of Grangeville, on the Salmon River, were worked by the Irbis Placer Co., and bullion recovered by hydraulicking was shipped to San Francisco and Seattle. The property is equipped with a giant and a derrick, both electrically driven.

Ten Mile district (Golden).—One placer and three lode mines in the Ten Mile district produced 383 tons of ore, \$12,936 in gold and 265 ounces of silver, valued together at \$13,091; the ore had an average value of \$33.34 in metals a ton. Most of the output was gold ore from the Lone Pine property and was treated in a 2-stamp amalgamation mill. The mine is 40 miles west of Grangeville. About 300 feet of tunnel work was done in 1928. The net returns, after transportation charges were deducted, were \$11,981. The vein was discovered in May, 1927, and has since been developed by nearly 600 feet of work in rich gold ore. The Central Idaho Gold Mines Co. was

organized to work the New York and Anaconda properties near Golden, and about \$900 in gold bullion was recovered by amalgamation. A 1-ton Eureka rod mill was installed at the Wonder property, and gold bullion was shipped to San Francisco and Denver. The Moose Creek placers were operated from May 1 to May 10 and produced a small quantity of gold bullion, which was marketed at San Francisco. Work done in 1928 consisted chiefly of testing the ground and constructing a flume and a pipe line.

Warren district.—Four placers and one lode mine in the Warren district produced 1,241 tons of ore, \$16,734 in gold and 542 ounces of silver, valued together at \$17,051. The placer bullion was valued at \$2,765 and came chiefly from the Golden Rule property on Grouse Creek, 6 miles east of Burgdorf, near the Secesh River. The property was worked by hydraulic mining from April 15 to July 1, and about 12,000 cubic yards of gravel was handled. Gold bullion was also recovered from the Buck Diggings on Huston Creek and from the Shissler Creek placer. The Little Giant mine of the Unity Gold Mines Co., 45 miles north of McCall, the nearest shipping point, was worked most of 1928 and produced gold bullion valued at more than \$14,000. In the past a 10-stamp amalgamation mill was used, but in November a ball mill and K & K flotation machine were added. The property ranked fifth as a producer of gold in Idaho in 1928.

KOOTENAI COUNTY

No production was reported from Kootenai County in 1928, but several properties such as the Burnt Cabin, Wolf Lodge, Blue Bird, Royal, and Caribou were being developed.

LEMHI COUNTY

The value of the mine production of metals in Lemhi County in 1928 decreased \$387,945 from that of 1927, a larger decrease than in any county except Shoshone. In contrast to the marked decrease in silver and lead the output of copper increased more than 300,000 pounds. The largest producer in the county was the Pittsburgh-Idaho property at Gilmore, but its output of lead in 1928 was only about one-fourth that of 1927, when it ranked seventh as a producer of lead in the State.

Blackbird district.—A small quantity of copper ore was shipped from the Copper King claim.

Blue Wing district.—The Patterson Mines Corporation did 1,000 feet of tunnel work to develop the Ima group, which is equipped with a 150-ton flotation mill for silver-copper-tungsten ore.

Carmen Creek district.—A little gold bullion was recovered from the Boyle Creek placer, near Carmen.

Eldorado district.—The Harmony mine near Baker produced 900 tons of copper ore, which was milled in a 200-ton flotation plant, and one car of copper concentrates was shipped to International, Utah, for smelting. Nearly 600 feet of development was done, chiefly in tunneling and drifting. The mill was rearranged during the latter part of 1928 so as to send a finer feed to the ball mill, and a filter was installed to dewater the concentrates. Various changes are said to have increased

the capacity of the mill 50 per cent. A car of first-class copper ore was shipped from the Mountain View property on Bohanan Creek, 7 miles east of the Lemhi River.

Eureka district.—One placer and four lode mines in the Eureka district produced 3,643 tons of ore, \$4,284 in gold, 1,144 ounces of silver, 414,319 pounds of copper, and 1,894 pounds of lead, valued in all at \$64,726; the ore had an average value of \$16.81 in metals a ton. The largest producer in the district was the Pope Shenon mine, 9 miles south of Salmon, worked by the Winder-Stillman Copper Co. The company treated more than 3,000 tons of copper ore in a small flotation plant, and the concentrates were shipped to International, Utah, for smelting. The property has become a fairly large producer of copper, and in 1928 it ranked second as a producer of copper in Idaho. A car of oxidized lead ore was shipped from the Red Cross property on the north side of Moose Creek, 4½ miles northwest of Salmon. A small quantity of gold ore from the Queen of the Hills and Miller properties was treated by amalgamation and the bullion sent to the assay office at Boise. The McNutt placer on Moose Creek, 18 miles north of Salmon, was operated from April to June and yielded gold bullion valued at nearly \$3,500. The property is worked by hydraulic and sluicing methods, and about 20,000 cubic yards of material was handled.

Gibbonsville district.—A clean-up containing chiefly gold from the Twin Brothers mill and the Golden Reward property was shipped to Anaconda, Mont. A small quantity of gold bullion was recovered by hydraulicking at the Sheep Creek placers near Salmon.

Gravel Range district.—Gold ore from the Rabbit Foot mine, owned by the Lemhi Mining Co., was treated by amalgamation and concentration. Gold bullion was shipped to the assay office at Helena, Mont., but the concentrates were held for future shipment. It was reported that development in 1927 had opened a large body of ore assaying about \$40 a ton in gold and silver.

Indian district.—Old tailings from the Kitty Burton property, near Ulysses, were treated by amalgamation, and a small quantity of gold bullion was sent to the assay office at Boise. This property was a large producer of gold from 1903 to 1915. Small quantities of placer gold were shipped from the Wallace property on Salmon River and from a property on Indian Creek.

Junction district.—The Grizzly Hill group was worked by the Continental Standard Mining Co., and one car of oxidized lead ore was shipped to Utah for smelting. Development consisted of 150 feet of tunneling and 100 feet of sinking.

McDevitt district (Tendoy).—Three cars of copper ore containing considerable gold were shipped from the Copper Queen property by the Tendoy Mining Co. The ore is hauled 10 miles to Tendoy, a station on the Gilmore & Pittsburgh Railroad. An old 25-ton concentration mill, equipped with two Wilfley tables, was rebuilt and operated early in 1929.

Mackinaw district (Leesburg).—Five placers in the Mackinaw district produced gold valued at \$2,247 and 8 ounces of silver. Most of the output came from the Hockensmith placer on Arnett Creek. The property was worked by hydraulicking from May 6 to September 1, and about 10,000 yards of gravel was handled. A large quantity

of gold was also produced from the Bonanza placer on Napias Creek. The gold fineness from placers in this district is extremely high, assaying from 0.900 to 0.928. Small quantities of placer gold were also recovered from the K. G. W., Arnett Creek, and Kirkpatrick claims. The Leesburg Gold Placers did considerable work in testing ground and installing hydraulic equipment.

Nicholia district.—Several cars of oxidized lead ore were shipped from the Viola mine, 21 miles south of Gilmore, and one car of similar ore was shipped from the Ida property on Viola Hill.

Pratt Creek district.—The Goldstone Mines Corporation was organized to operate the Goldstone mine, a former producer of gold. In 1928 the 20-ton amalgamation and concentration plant was operated, and gold bullion valued at about \$800 was shipped to the assay office at Boise; the plant also made 6 tons of lead concentrates, containing nearly 3 ounces of gold to the ton, which were not shipped. The company plans to increase the capacity of the mill to 100 tons a day and add flotation cells. A body of ore assaying nearly \$13 per ton in gold, silver, and lead is said to have been opened on the 500-foot level. Two cars of siliceous gold ore were shipped from the Clearwater property, 5½ miles east of Baker. The ore, which is said to be suitable for concentration, averages about \$12 a ton in gold and contains 5 per cent of lead.

Spring Mountain district.—The Big Windy property, 10 miles southwest of Gilmore, was worked by the Spring Mountain Mining Co. and two cars of oxidized lead ore were shipped to the smelter at Midvale, Utah.

Texas district (Gilmore).—In 1928 four lode mines in the Texas district produced 6,253 tons of ore, yielding \$3,338 in gold, 56,220 ounces of silver, 13,475 pounds of copper, and 2,389,636 pounds of lead, valued in all at \$176,766, or \$28.27 in metals a ton. In 1927 three lode mines produced 14,011 tons of ore, yielding \$10,457 in gold, 202,831 ounces of silver, 56,539 pounds of copper, and 7,790,701 pounds of lead, valued in all at \$623,682, or \$44.51 in metals a ton. The largest producer in both 1927 and 1928 was the Pittsburg-Idaho property, operated by the United Idaho Mining Co., a subsidiary of the United States Smelting, Refining & Mining Co. Shipments in 1928 consisted of nearly 3,000 tons of oxidized silver-lead ore and more than 300 tons of lead concentrates. A 50-ton concentrator equipped with jigs and tables was operated on a part-time basis. In 1927 the property was the largest producer of silver and lead in southern Idaho, but the output in 1928 decreased considerably. The Gilmore mine, owned by the Gilmore Mercantile Co., ranked second as a producer in the district in 1928. About 1,700 tons of oxidized lead ore was shipped to Midvale for smelting, and 1,400 feet of development was done, chiefly in drifts and crosscuts. The mine was worked continuously, but after August 1 it was operated under lease and bond by the United States Smelting, Refining & Mining Co. The Latest Out property, a large producer of lead and silver from 1922 to 1925, was also leased and produced two cars of oxidized lead ore of smelting grade.

Yellow Jacket district.—A small quantity of gold bullion recovered from a clean-up around the Yellow Jacket mill was shipped to the mint at Denver.

OWYHEE COUNTY

The mine production of metals in Owyhee County in 1928 was valued at \$20,759, an increase of \$12,221 over 1927. The increase was due to the work of the new dredge of the American Gold Dredging Corporation, near Triangle. From 1863 to 1928 the county yielded \$21,715,922 in gold and 24,614,043 ounces of silver, or a value of \$40,700,481 for both metals.

Carson or French district (Silver City).—In 1928, 10 lode mines in the Carson district produced 270 tons of ore, yielding \$1,619 in gold and 3,294 ounces of silver, valued together at \$3,546, or \$13.13 in metals a ton. In 1927 one placer and seven lode mines produced gold, silver, and a small quantity of copper and lead, valued in all at \$7,824. The output in 1928 consisted of 11 tons of first-class smelting ore, 200 tons of ore of concentrating grade, and 54 tons of ore and 5 tons of old cleanings amalgamated. The largest producer in the district was the Neversweat property, operated by lessees, who treated about 200 tons of gold and silver ore in a 40-ton Marcy rod mill equipped with Wilfley tables and flotation cells. A small lot of rich concentrates containing about 17 ounces of gold and 1,000 ounces of silver to the ton was shipped to the smelter at International, Utah. The Owyhee Gold Mining Co. worked the Mountain Chief property and treated about 50 tons of siliceous gold ore by amalgamation as a mill test; gold bullion valued at about \$200 was sent to the assay office at Boise. A small quantity of gold bullion recovered by amalgamation in the mill of the Silver City Mining & Milling Co. and a little gold bullion from a clean-up around the Wagner mill were marketed. Small quantities of rich gold ore were shipped from the Browney and Goldbug claims, small lots of rich silver ore from the Alpine and War Eagle mines, and a test lot of gold and silver ore from the Village Blacksmith mine. The De Lamar property, a large producer in the past, was idle in 1928, but lessees recovered 16 flasks of quicksilver by placering material deposited in the creek from former operations. More than 1,000 feet of development was done in the Chapman group of the Great Western Mines Co.

Castle Creek district.—The Castle Creek Mining & Milling Co., owner of the Blue Bird property near Grandview, tested a little silver ore in a flotation plant. A lessee on the Happy Boy mine shipped a small lot of first-class gold ore. The Lucky Day prospect was being developed by the Owyhee Silver Mines Co., and a concentration plant was being constructed.

Steele district.—The American Gold Dredging Corporation ranked fourth as a producer of gold in Idaho in 1928. The corporation operated a dredge on Meadow Creek, near Triangle, and recovered a large quantity of gold bullion which was shipped to the assay office at Boise. An electric dredge, equipped with thirty-six 2½-cubic-foot buckets, operated about six months. As the gravel channels are said to be narrow and steep, it was impossible to run the plant at full capacity.

SHOSHONE COUNTY

Mine production of gold, silver, copper, lead, and zinc in the Coeur d'Alene region, Shoshone County, Idaho, 1927-28, and total, 1884-1928

Year	Lode mines	Placers	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc	Total value
			<i>Short tons</i>		<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	
1927.....	49	5	1,919,309	² \$8,596	8,256,126	1,306,773	283,896,615	52,262,188	\$26,091,273
1928.....	42	4	1,949,980	² 8,838	8,513,048	1,044,105	278,551,953	57,329,671	24,792,445
Total, 1884-1928.....			(³)	7,148,529	237,665,650	78,741,511	⁴ 3,938,048	662,879,330	672,396,616

¹ Includes old tailings, as follows: 1927, 172,819 tons concentrated; 1928, 179,529 tons concentrated.

² Includes placer production, as follows: 1927, \$1,067 in gold and 4 ounces of silver; 1928, \$1,320 in gold and 11 ounces of silver.

³ Figures not available.

⁴ Short tons.

The value of the mine production of metals in Shoshone County, which includes the Coeur d'Alene region, was \$24,792,445 in 1928, or \$1,298,828 less than the value in 1927; the loss was mainly the result of the decline in the price of lead, the output of which decreased more than 5,000,000 pounds. The average total value of the ore and old tailings in 1928 was \$12.71 in recovered metals a ton, and the value in gold and silver, chiefly silver, was \$2.56 a ton. The kinds of ore (largely lead ore and lead-zinc ore with some copper ore and copper-lead ore) and the contents of each kind have been given in preceding tables.

Most of the ore, as well as 179,529 tons of old tailings, was concentrated and produced 299,061 tons of concentrates, yielding on the average \$76.50 in metals a ton. Twenty milling plants, with a combined daily capacity of approximately 7,800 tons, were active during the year. Four of these mills used equipment for gravity concentration and flotation; 16 were wholly flotation mills and had no tables. There were large increases in silver and zinc, but a notable decrease in lead. A large increase in lead from lead concentrates made from lead-zinc ore offset a large decrease in lead from lead concentrates made from lead ore, but there was a decrease of nearly 13,000,000 pounds in lead from crude lead ore of smelting grade. There was a small increase in gold and a decrease in copper. The three largest producers of silver and lead and the largest dividend payers in Idaho—the Bunker Hill & Sullivan, Morning, and Hecla mines—are in Shoshone County, at Kellogg, Morning, and Burke. The statement to the county assessor gave \$6,842,499 as the net profits of the Coeur d'Alene mines and leases in 1928, a decrease from \$7,139,888 in 1927. The gross value of the ore and concentrates produced in 1928 was \$23,799,205, a slight increase compared with \$23,564,645 in 1927.

For further details regarding the mining industry of Idaho, reference is again made to the comprehensive annual report of the State mine inspector for 1928, which gives the producing and developing companies arranged by counties, the accident statistics, and an interesting bibliography for each county. It was estimated that 6,500 men were employed in Idaho mines in 1928.

Beaver district.—The Yolande Mining Co., operating the Tuscumbia property under lease, shipped two cars of high-grade sulphide lead ore to East Helena, Mont., for smelting. A body of ore containing chiefly galena was said to have been opened in the Idora tunnel. Late in the year the property was taken over by the North American Mining & Smelting Corporation. Placer bullion valued at \$870 was recovered from the Lock & Erwin, Rich Man & Poor Man, and Sam Ward claims. The Interstate-Callahan property,⁴ north of Wallace, remained practically idle, and the company has confined its efforts to the Galena mine southwest of Wallace, the production of which is given under Placer Center district. The following paragraphs are taken from the printed annual report of the company for 1928:

The old property at Interstate, which was for several years the second largest zinc producer in the United States, has not been in operation since 1923. When this property closed down there were estimated ore reserves of 60,000 tons. * * *

There are several factors that encourage us to believe that this property has a future depending on a rise in the price of zinc and the improvement in metallurgical processes. * * *

North of this property lie several very promising properties which have not been developed, largely because of their inaccessibility.

There is no question but that these adjoining properties can be operated more economically through our Interstate property.

Coeur d'Alene district.—No production has been reported from the Coeur d'Alene district at Murray since the closing and removal of the dredge of the Yukon Gold Co. in 1926.

Eagle district.—The Jack Waite Consolidated Mining Co., which owns the Jack Waite group in Idaho and the adjoining Silver King group in Montana, was the only producer in the district in 1928. The mine was worked throughout the year, but the 150-ton selective flotation mill was operated only six months. The capacity of the mill was increased from 90 tons to 150 tons a day, and the process was changed from gravity concentration with jigs and tables to straight flotation. The company treated more than 20,000 tons of lead-zinc ore, which was reduced to about 2,500 tons of lead concentrates and zinc concentrates. The product was hauled 4 miles southwest to Prichard, a loading station on the line of the Oregon-Washington Railroad & Navigation Co. Two cars of first-class sulphide lead ore were also mined and shipped to the smelter at Bradley. The property produced lead concentrates containing more than 2,000,000 pounds of lead and zinc concentrates containing nearly 900,000 pounds of zinc. The zinc concentrates, however, were stored for shipment in 1929. The Jack Waite mine has become the most important producer in the vicinity of the North Fork of the Coeur d'Alene River, and considerable work in surface improvement and deeper development was done in 1928. According to the statement given to the county assessor, the concentrates had a gross value of \$39,227; the cost of extraction was \$20,685 and freight and treatment \$1,385; the net profit was \$17,157.

Evolution district.—In 1928 four lode mines in the Evolution district produced 52,052 tons of ore, which, with 450 tons of old tailings, yielded \$309 in gold, 1,131,086 ounces of silver, 184,358 pounds of copper, 1,580,730 pounds of lead, and 78,661 pounds of zinc, valued in all at \$785,022, or \$14.95 in metals a ton. With the exception of the old tailings and 46 tons of first-class smelting ore, the output was

⁴ Callahan Zinc-Lead Co. Ann. Rept. for 1928.

all ore of concentrating grade. In 1927 four lode mines produced 41,521 tons of ore and old tailings, yielding \$2 in gold, 1,058,833 ounces of silver, 255,844 pounds of copper, 1,472,919 pounds of lead, and 43,659 pounds of zinc, valued in all at \$729,463, or \$17.57 in metals a ton. In both 1927 and 1928, the output was chiefly that of the Sunshine Mining Co., which operated the Yankee Boy mine, east of Big Creek. In 1928 the mine and the 150-ton flotation plant were operated regularly, and about 1,900 tons of copper-lead concentrates, exceptionally rich in silver, was shipped to the smelter at Bradley. The property is opened to a depth of 500 feet by various drifts and tunnels; development in 1928 consisted of 3,556 feet of drifts and crosscuts, 1,710 feet of raises, and 247 feet of winze sinking. New machinery, including an 8-cell Minerals Separation machine, was added to the present equipment. The property ranked fourth as a producer of silver in the State in 1927 and 1928 and paid dividends in 1928 amounting to \$180,000, which makes a total of \$300,000 paid since its initial dividend of \$120,000 paid in 1927. As the development at depth has been encouraging, the company is planning to make other additions to the mill in 1929. The predominant mineral is tetrahedrite, and the concentrates are therefore far more valuable for silver than the usual galena concentrates from the Coeur d'Alene region. One car of rich concentrates shipped in 1928 contained more than 800 ounces of silver to the ton. According to the figures given to the county assessor, the company extracted 49,206 tons of ore, which had a gross value of \$684,340. The cost of extraction was \$238,769, freight and treatment \$82,931, and betterment and repairs \$52,244; the net profit was \$310,396. In 1927 the gross value of the ore was \$595,291 and the net profit \$290,484. The Dickens Consolidated Mines Co. constructed a new 150-ton flotation plant, which was operated late in the year; the company shipped nearly 300 tons of lead concentrates. The product is hauled 3 miles to Shonts, a station of the Oregon-Washington Railroad & Navigation Co. Development in 1928 consisted of 1,000 feet of crosscuts and drifts and of sinking the vertical shaft from the 500 to the 700 foot level. Active development was done at the Coeur d'Alene Crescent and Silver Summit groups. The Western Union mine was idle in 1928 except for work done by lessees who shipped a car of first-class sulphide lead ore to the Bunker Hill smelter at Bradley. Old tailings from a creek bed were treated, and the resulting zinc concentrates were shipped to the electrolytic zinc plant at Anaconda, Mont.

Hunter district (Mullan).—In 1928 six lode mines in the Hunter district produced 557,955 tons of ore, yielding \$3,062 in gold, 2,135,038 ounces of silver, 105,576 pounds of copper, 77,803,920 pounds of lead, and 33,116,808 pounds of zinc, valued in all at \$7,800,014, or \$13.98 in metals a ton. In 1927 seven lode mines produced 577,224 tons of ore, yielding \$2,751 in gold, 2,268,899 ounces of silver, 326,040 pounds of copper, 82,172,579 pounds of lead, and 31,178,860 pounds of zinc, valued in all at \$8,504,248, or \$14.73 in metals a ton. The output from this district in 1927 and 1928 was more valuable than that from any other district in Idaho except the Yreka. The output in 1928 consisted of 8,372 tons of first-class ore and of 549,583 tons of concentrating ore, which was reduced to 94,095 tons of concentrates, compared with 26,337 tons of first-class ore and 550,887 tons of concentrating material in 1927.

The Morning mine of the Federal Mining & Smelting Co. ranked first as a producer of zinc, second as a producer of lead, and third as a producer of silver in Idaho in 1928. As in the past, lead ore and concentrates were shipped to East Helena, Mont., and the zinc product was shipped to the electrolytic plant at Great Falls, Mont. The mine is opened by a vertical shaft 2,545 feet below the main adit level, by 29,423 feet of drifts, and by a main adit tunnel 10,000 feet long. More than 4,100 feet of development, chiefly in drifting and crosscutting, was done in 1928. The 1,200-ton mill was completely overhauled in 1927 and is now a selective flotation plant. Since these changes went into effect the grade of both the lead concentrates and the zinc concentrates has been improved. The company, which also operates mines in Kansas, Missouri, and Oklahoma, paid dividends in 1928 amounting to \$485,292, making a total of \$23,558,039 to date. The net earnings since 1904 have been \$37,234,395.

According to the figures given to the county assessor, ore extracted from the Morning mine had a gross value of \$6,516,198. The cost of extraction was \$2,371,731, freight and treatment \$2,176,852, and betterment and repairs \$111,285; the net profit was \$1,856,330. In 1927 the ore had a gross value of \$6,924,809, and after various costs were deducted the net profit was \$1,888,565. The printed annual report of the company for 1928 gives the following data:

The ore mined amounted to 391,669 tons, being 6,854 tons less than in 1927. The average grade of the ore was: 9.17 per cent of lead, 4.35 ounces of silver per ton, and 5.80 per cent of zinc.

There was a further improvement in the mill recoveries, and the grade of the lead concentrates was raised to 71 per cent, or 5 per cent higher than in 1927. * * *

During the year the mine shaft was sunk to the 3,450 level. The vein was cross-cut on the 3,250 and 3,450 levels and was found to be of normal width on both, with ore of better than the average value.

Developed ore at the end of the year was estimated at 1,867,600 tons, an increase of 147,500 tons over the estimated tonnage at the end of 1927. No account is taken here of possible ore, but there is no doubt that a large additional tonnage will be developed as the workings attain greater depth.

The Morning mine is now probably in the upper horizon of the Burke quartzite, which immediately overlies the Prichard slate. But the distance it has gone in, the angle at which it is cutting, and the thickness of the Burke quartzite at that particular place are all wholly unknown. Quite possibly the Morning mine may have a further depth of a thousand feet, and even more. It is also possible that it may be bottomed in a few hundred feet. All that we really know is that up to date, and at the lowest level reached in this mine, there is no sign of approaching termination. In fact, the ore found on the lowest level (3,450) is richer in metal content where cut than on any level above.

From 391,669 tons of ore, including lead-zinc ore milled and first-class lead ore smelted, lead products containing 1,453,775 ounces of silver and 64,026,000 pounds of lead were made, and zinc concentrates containing 192,811 ounces of silver, 2,628,000 pounds of lead, and 36,570,000 pounds of zinc were shipped. Lessees also produced several hundred tons of ore that contained 81,558 ounces of silver and 2,914,000 pounds of lead.

The Gold Hunter Mines (Inc.) operated its 500-ton flotation plant the entire year and shipped more than 9,000 tons of silver-lead concentrates to the Bunker Hill smelter at Bradley. The mine is opened by a vertical shaft 2,000 feet deep, by 2,210 feet of raises, and by about 10 miles of drifts and crosscuts; in 1928, 1,149 feet of drifting and crosscutting was done, and the shaft was sunk 130 feet deeper. The mine ranked fifth as a producer of silver in Idaho in 1928 and

sixth as a producer of lead. According to the figures given to the county assessor, the company extracted 133,160 tons of ore, which had a gross value of \$678,038. The cost of extraction was \$422,314, freight and treatment \$185,330, and betterment and repairs \$1,074; the net profit was \$69,320. In 1927 the company extracted 130,742 tons of ore, which had a gross value of \$642,656, and after various costs were deducted the net profit was \$39,073.

The Sullivan Mining Co., owner of the Star mine, which is controlled by the Hecla Mining Co. and the Bunker Hill & Sullivan Mining & Concentrating Co., shipped about 4,500 tons of lead-zinc ore late in the year to the South mill of the Bunker Hill Co. at Kellogg; there it was separated into lead concentrates, which were smelted at Bradley, and zinc concentrates, which were shipped to the electrolytic plant of the Sullivan Mining Co. at Silver King. The mine is developed by a 9,000-foot crosscut from the 2,000-foot level of the Hecla mine, but in 1928 only repair and timbering work was done. The new electrolytic zinc plant of the Sullivan Mining Co. began operations in June, 1928. It is expected that the Star mine will be a large producer of zinc in 1929 and thereafter, as the ore reserves are sufficient to supply the plant for many years. The following paragraph is taken from the report of the Hecla Mining Co. for 1928:

The zinc plant under construction by the Sullivan Mining Co. shipped its first product under the trade name of "Bunker Hill" in November. The plant has a capacity of 1,800 tons monthly of slab zinc and is now producing 1,500 tons monthly. Full capacity will be reached at an early date. Ore supplies for the plant come from a stock pile accumulated during the construction period—mostly from the Sidney mine. Production on a small scale has been started from the Star mine of the Sullivan Mining Co., which will be increased as the zinc plant is brought to capacity.

The Golconda Lead Mines was organized in 1927 to work the Hector property, and in 1928 the mine was operated the entire year. During the first part of the year more than 1,000 tons of lead-zinc ore was shipped to the Hercules custom flotation plant for milling. In August the company completed the construction of a new 200-ton selective flotation plant, which was operated throughout the balance of the year; zinc concentrates were shipped to Anaconda and lead concentrates to East Helena, Mont. The mine is opened by a vertical shaft 250 feet deep and a tunnel 3,100 feet long; nearly 3,000 feet of work, chiefly in drifting and raising, was done in 1928. The property ranked eighth as a producer of zinc in Idaho in 1928 and twelfth as a producer of lead. The holdings of the company were increased by the acquisition of the Mayflower property in November. According to the figures given to the county assessor, the company extracted 21,134 tons of ore, which had a gross value of \$330,705. The cost of extraction was \$114,817, freight and treatment \$135,119, and betterment and repairs \$120,774; the net loss was \$40,005.

The Lemhi property, owned by the Butte & Coeur d'Alene Mining Co., was operated under lease, and one car of lead-zinc mill ore was shipped to the Hercules custom mill for testing purposes. More than 1,000 feet of development was done in 1928, chiefly in cross-cutting. One car of first-class copper ore was shipped from the Snow Storm mine, which was also under lease. The property was formerly the largest copper producer in Idaho, and in 1926 and 1927 flotation concentrates were made by a leasing company. At the Atlas, Mutual, and Independence properties continuous development was carried on.

Lelande district (Burke, Mace, Frisco).—In 1928 six lode mines in the Lelande district produced 348,025 tons of ore and old tailings, which yielded \$1,052 in gold, 1,960,820 ounces of silver, 350,003 pounds of copper, 64,482,771 pounds of lead, and 6,108,149 pounds of zinc, valued in all at \$5,311,130, or \$15.26 in metals a ton. In 1927 nine lode mines produced 312,181 tons of ore and old tailings, yielding \$398 in gold, 1,921,153 ounces of silver, 408,330 pounds of copper, 62,105,207 pounds of lead, and 2,705,483 pounds of zinc, valued in all at \$5,228,962, or \$16.75 in metals a ton. In 1928 the output consisted of 19,211 tons of first-class ore and of 325,668 tons of concentrating ore, which, with 3,146 tons of old tailings, was reduced to 53,895 tons of concentrates, compared with 21,554 tons of first-class ore and of 290,467 tons of concentrating ore, which, with 160 tons of old tailings, was reduced to 46,790 tons of concentrates in 1927.

The Hecla Mining Co. at Burke, which shipped first-class lead ore and concentrates to the Bunker Hill smelter at Bradley, was the largest producer in the district. The mine is opened by a 2,240-foot vertical shaft and various drifts, and 5,919 feet of development was done in 1928. About 2,489,497 tons of ore is said to be in reserve. The 750-ton concentration plant at Gem was operated regularly, as well as the flotation plant for the re-treatment of jig tailings. The company ranked third as a producer of lead in Idaho, and was second only to the Bunker Hill & Sullivan mine in the production of silver. The dividend rate was reduced in 1928, the company having paid \$700,000 as against \$1,000,000 in 1927; the total dividends paid to date amount to \$17,805,000.

Of the ore mined, 256,104 wet tons was milled, making 40,057 tons of concentrates, which, with 19,257 tons of crude ore, were smelted and contained 1,740,082 ounces of silver and 59,004,944 pounds of lead. According to the published reports of the company, the output of the Hecla mine for 25 years was 843,918 tons of crude ore and concentrates, containing 23,793,955 ounces of silver, 855,653,611 pounds of lead, and 994,581 pounds of crude zinc.

According to the figures given to the county assessor, 313,500 tons of ore and waste was extracted in 1928, which had a gross value of \$4,319,023. The cost of extraction was \$1,363,173, freight and treatment \$914,606, and betterment and repairs \$93,690; the net profit was published as \$1,947,554. After paying \$1,583,352 for various expenses and deducting \$93,792 for depreciation, the company paid \$211,267 in taxes and \$700,000 in dividends, which left a surplus of \$4,655,608 on December 31, 1928. In 1927 the ore had a gross value of \$4,730,123 and the net profit was \$2,028,600. Additional notes from the company's printed annual report follow:

Late in the year a small production of approximately six tons daily of zinc concentrates from Hecla ores commenced. These concentrates will go to the Sullivan zinc plant. None had been shipped at the time this was written. With present prices this production should result in an added income of \$50,000 annually. * * *

Ore reserves at the end of the year totaled 2,489,497 tons. Our last annual report reviewed the development results to the 2,800-foot level. The work of development from the 2,000 to the 2,800 foot level has been carried on through a winze, because the main hoisting equipment does not permit hoisting from depths below 2,000 feet. The tonnage disclosed in this work justified the sinking of the main shaft and the purchase of heavier hoisting equipment. The main shaft has been sunk to the 2,800-foot level, heavier equipment has been ordered and will be in place and in use, we expect, in September. Following the installation of

this equipment the 2,800-foot level will be connected with the main shaft. The work just outlined should be finished by April or May, 1930. * * *

During the year we unwatered the Tiger-Poorman mine to the 600-foot level to examine the westerly end of that property to determine whether or not commercial ore of mixed zinc-lead existed there. This property was worked to exhaustion when ores of the character mentioned were not commercial and before the present development in metallurgy permitted the separation and recovery of these minerals. We recovered and examined the 300 and 600 foot levels, explored them to their westerly extremity, drifted a short distance, did a small amount of crosscutting and failed to find ore. We are again allowing the mine to fill with water.

The Hercules Mining Co. continued to develop several groups under its control, including the Ambergris, Humming Bird, Maher-Hearn, Honolulu, Roanoke, and Stanley properties. The company also remodeled its mill at Wallace and operated it as a custom flotation plant; the plant treated about 158,000 tons of ore, chiefly from the Tamarack & Custer, Dayrock (Strattons), Sherman, Humming Bird, and Golconda properties.

The Sherman Lead Co. operated its property the entire year and mined more than 37,000 tons of lead-zinc ore; the ore was treated in the Hercules custom mill, where it was separated into lead concentrates and lead-zinc concentrates. The ore, however, contains more than three times as much lead as zinc. The property ranked eighth as a producer of lead in Idaho in 1928, tenth as a producer of zinc, and twelfth as a producer of silver. The mine is opened by 10 tunnels and levels aggregating 21,200 feet, 6 raises aggregating 1,734 feet, and a 100-foot shaft. In 1928 nearly 3,700 feet of work was done, chiefly in tunneling. According to a statement given to the county assessor, the company extracted 38,460 tons of ore, which had a gross value of \$520,575. The cost of extraction was \$206,393, freight and treatment \$309,784, and betterment and repairs \$4,757; the net loss was \$359. The Humming Bird Mining Co., operated under the control of the Hercules Mining Co., shipped nearly 15,000 tons of lead-zinc ore to the Hercules custom mill, where it was separated into lead concentrates and zinc concentrates. The property ranked ninth as a producer of zinc in Idaho in 1928; it was also a large producer of lead.

At the Frisco group of the Federal Mining & Smelting Co., a 75-ton flotation plant was operated by lessees who shipped about 1,000 tons of lead concentrates to East Helena, Mont., and 3,200 tons of zinc concentrates to Great Falls, Mont. The mine ranked fifth as a producer of zinc in Idaho in 1928. According to the statement to the county assessor, the gross value of the output was \$253,376; the cost of extraction was \$121,120 and freight and treatment \$110,842, leaving a net profit of \$21,414. The Mace mine of the Federal Mining & Smelting Co. produced 616 tons of ore, most of which was milled at the custom plant at Butte, Mont., where it was separated into lead concentrates and lead-zinc concentrates. Several cars of first-class sulphide lead ore were shipped to East Helena, Mont., for smelting. No development was done in 1928, and the output was ore from old stopes shipped by lessees. The remainder of the district output consisted of more than 3,000 tons of old lead-zinc tailings recovered from Canyon Creek and shipped to the Hercules custom mill. The material contained about 11 per cent of zinc, 4 per cent of lead, and 3 ounces of silver to the ton. Active development was done at the Ajax and Anchor properties.

Placer Center district (Sunset).—In 1928 seven lode mines in the Placer Center district produced 160,773 tons of ore, yielding \$607 in gold, 641,005 ounces of silver, 168,575 pounds of copper, 22,273,722 pounds of lead, and 7,288,748 pounds of zinc, valued in all at \$2,136,360, or \$13.29 in metals a ton. In 1927 the same number of lode mines produced 121,446 tons of ore, yielding \$79 in gold, 675,369 ounces of silver, 98,348 pounds of copper, 23,052,849 pounds of lead, and 523,213 pounds of zinc, valued in all at \$1,881,712, or \$15.49 in metals a ton. The entire output in 1928 was ore of concentrating grade, which yielded 30,317 tons of concentrates, compared with 673 tons of first-class lead ore and of 120,773 tons of ore of concentrating grade, which yielded 24,523 tons of concentrates in 1927.

As in recent years, the Tamarack & Custer property was the largest producer in the district in 1928. The 400-ton concentration-flotation plant at Frisco was operated until May 15, when it was shut down; thereafter all the lead-zinc ore was delivered through the No. 7 tunnel and shipped to the Hercules custom mill at Wallace. The lead product was shipped to East Helena, Mont., and the zinc product to Great Falls, Mont. The mine was operated the entire year, and more than 4,600 feet of work was done, chiefly in drifting and cross-cutting. The company issued no printed report giving details of its operations, but it was reported that much new ore had been added to the reserves. About 85 per cent of the concentrates is a flotation product and the remainder table concentrates. The mine ranked second as a producer of zinc in Idaho in 1928, fourth as a producer of lead, and sixth as a producer of silver. According to the figures given to the county assessor, the company shipped 82,552 tons of concentrates and mill ore, which had a gross value of \$1,639,176. The cost of extraction was \$689,436, and freight and treatment \$974,222; the net loss was \$24,482. The production in 1927 was 19,492 tons of concentrates and mill ore, which had a gross value of \$1,155,641; after various costs were deducted the net loss was \$38,727.

The Strattons Mines Co. worked the McPhillips and Panhandle groups most of 1928, but late in the year the Dayrock Mining Co. was organized as its successor. Several thousand tons of lead-zinc ore was milled at the Hercules custom plant, where it was separated into lead concentrates and lead-zinc concentrates. The chief product, however, is lead concentrates, as the mill ore contains seven times as much lead as zinc. The property ranked second as a producer of silver and lead in the Placer Center district in 1928; it ranked ninth as a producer of silver and seventh as a producer of lead in the State. According to the figures given to the county assessor, both companies extracted 22,117 tons of ore, which had a gross value of \$492,922. The cost of extraction was \$125,805, freight and treatment \$218,964, and betterment and repairs \$5,506; the net profit was \$142,647. In 1927 the Strattons Co. extracted 17,486 tons of ore, which had a gross value of \$272,013; after various costs were deducted the net profit was \$19,706.

The Galena mine of the Callahan Zinc-Lead Co. ranked eleventh as a producer of silver and ninth as a producer of lead in the State. The mine was worked continuously, and nearly 1,500 feet of development was done, chiefly in drifting. The 150-ton flotation plant was operated the entire year, and more than 3,000 tons of lead concentrates were shipped to East Helena, Mont. The mill, which

drops zinc and makes only silver-lead concentrates, was operated at capacity during the first six months of the year, but after June it ran only on ore taken out in the course of development. According to the figures given to the county assessor, 33,887 tons of ore was extracted and milled, which had a gross value of \$199,215. The cost of extraction was \$209,298 and freight and treatment \$13,279; the net loss was \$23,362. In 1927 the company extracted and milled 54,698 tons of ore, which had a gross value of \$434,930; after various costs were deducted the net profit was \$76,073. The printed report of the Callahan Zinc-Lead Co. gives the following paragraphs:

We suspended mining during the early part of October, 1928, because of the fact that the ore coming from the mine was running too low grade to be handled at a profit. Our operations since that time have been confined to development and exploration work.

In order to explore for parallel veins at the Galena mine we installed a diamond drill outfit and drove to the south from the workings on the Galena vein at a point 1,880 feet east of the main shaft on the 600 level. At a distance of 275 feet a parallel vein was disclosed. We immediately started to crosscut following the drill hole and opened up the vein disclosing ore eight feet in width, assaying 9.4 per cent of lead and 6.3 ounces of silver with no zinc. This vein has been drifted on to the west for approximately 60 feet, the ore varying in width. At the present time we have five feet of ore in the face of the drift.

Lessees operated the Rex mine of the Delaware Mines Corporation and shipped a few hundred tons of lead-zinc ore to the Hercules custom mill at Wallace, Idaho, and to the Timber Butte custom mill at Butte, Mont. The company did considerable prospecting of the Rex vein through the Red Monarch tunnel. A lessee operated the Patuxent property and shipped one car of lead ore to Wallace for milling. The output of the Success mine, formerly a large producer of zinc, consisted of a little lead-zinc ore extracted from the upper levels by lessees and treated at a custom mill. The old 200-ton concentration plant at the property was partly dismantled in 1927, and no development at the mine has been done since.

Summit district.—In 1928 one placer and five lode mines in the Summit district produced 2,958 tons of ore, \$959 in gold, 7,979 ounces of silver, 1,543 pounds of copper, 541,958 pounds of lead, and 66,355 pounds of zinc, valued in all at \$41,331; the ore had an average value of \$13.82 in metals a ton. In 1927 four lode mines produced 153 tons of ore, yielding gold, silver, lead, and zinc valued at \$11,807, or \$77.17 in metals a ton. In 1928 most of the ore in the district was lead ore of milling grade from the Cedar Creek property, near Murray. A new 100-ton flotation plant was constructed and operated two months, treating more than 2,000 tons of ore. The lead concentrates are hauled 12 miles to Prichard, a station on the branch line of the Oregon-Washington Railroad & Navigation Co., whence they are shipped to Bradley for smelting. The property is opened by two inclined shafts aggregating 1,343 feet, three tunnels aggregating 4,050 feet, 3,280 feet of drifts, and 580 feet of crosscuts. Development in 1928 consisted of 420 feet of drifting and crosscutting. The Bear Top mine in Bear Gulch, 8 miles from Murray, was operated by a lessee, who shipped a car of sulphide lead ore to Bradley for smelting. Several cars of lead-zinc ore were shipped by lessees from the Orofino property and milled at a custom flotation plant. A few cars of first-class lead ore were also produced and shipped to East Helena, Mont., for smelting. A small quantity of exceedingly rich gold ore from the

Pilot property, at Murray, was shipped to Bradley for smelting. The Terrible Edith mine was worked by the Pontiac Land & Mineral Co., and one car of lead-zinc ore was shipped to a custom flotation mill as a test. The company did 200 feet of raising in 1928, and it is said that enough ore was opened to justify the construction of a 50-ton flotation mill. Gold bullion valued at \$454 was recovered by sluicing stream gravel at the American placer in Buckskin Gulch, near Murray.

Yreka district (Kellogg).—In 1928, 12 lode mines in the Yreka district produced 631,493 tons of ore which, with 175,933 tons of old tailings, yielded \$868 in gold, 2,624,288 ounces of silver, 225,828 pounds of copper, 109,770,286 pounds of lead, and 9,880,950 pounds of zinc, valued in all at \$8,538,011, or \$10.57 in metals a ton. In 1927, 16 lode mines produced 675,789 tons of ore which, with 170,481 tons of old tailings, yielded \$4,235 in gold, 2,320,339 ounces of silver, 213,428 pounds of copper, 112,569,293 pounds of lead, and 17,779,736 pounds of zinc, valued in all at \$9,577,595, or \$11.32 in metals a ton. The output in 1928 consisted of 7,391 tons of first-class smelting ore and 624,102 tons of milling ore which, with 175,933 tons of old tailings, yielded 115,640 tons of concentrates, compared with 5,495 tons of first-class smelting ore and 670,294 tons of milling ore which, with 170,481 tons of old tailings, yielded 132,793 tons of concentrates in 1927. The value of the output of Yreka district in 1927 and 1928 was the largest of any district in Idaho.

The Bunker Hill & Sullivan Mining & Concentrating Co. operated its mine at Kellogg continuously; the North or main mill was operated on Bunker Hill ore and the South or Star mill on Star ore (one month) and old tailings from the Sweeny dump. The Sweeny mill was completely overhauled and changed to a custom flotation plant for the treatment of complex lead-zinc ore, chiefly from the Sidney mine. The company controlled the operations of several mining properties near by, including the Crescent, Big Creek, Caledonia, and Sierra Nevada. In 1928 the Bunker Hill property was the largest producer of silver and lead in Idaho. According to a statement given in the company's printed report for 1928, the mine produced 1,769,528 ounces of silver and 91,241,389 pounds of lead, compared with 1,799,891 ounces of silver and 94,971,072 pounds of lead in 1927. The production of lead in 1927 was the largest for any year in the history of the mine. At the various plants near Kellogg the company mines, mills, smelts, and refines its ores, and disposes of fine gold and silver, pig lead, and antimonial lead. With the addition of the new electrolytic zinc plant the company also marketed exceptionally fine zinc. The mine is worked to a depth of 1,900 feet through the Kellogg adit, which is 14,200 feet long. There are two inclined shafts, one 2,725 feet long and one 3,075 feet long. According to the figures given to the county assessor, 452,345 tons of ore was extracted, which had a gross value of \$6,753,032. The cost of extraction was \$1,915,955; freight and treatment, \$2,345,599; and betterment and repairs, \$173,459. The net profits, including royalties and mill work, were \$2,318,019. In 1927 the company extracted 456,134 tons of ore, which had a gross value of \$6,910,721; after various costs were deducted the net profits, including royalties and mill work, were \$2,632,937. Dividends aggregated \$3,003,962 in 1928, or a total of \$42,772,510 paid since 1890. The company treated nearly 143,000 tons of old tailings from the Sweeny dump, and the concentrates were

sent to the Tainton electrolytic lead plant. The following notes are taken from the company's printed annual report for 1928:

The mines and reduction plants of the company were operated satisfactorily throughout the entire year with production very close to the record of 1927.

* * *

No shaft sinking was done during the year, but extensive lateral exploration work was accomplished on several levels. Further development was done on the ore exposed on the No. 19 level east, noted in my last report. On the same bottom level of the mine, 2,000 feet vertically below the Kellogg adit tunnel, an important ore body was exposed by the westerly workings. The extent of this new ore is not yet shown, as development continues. It is not believed to be the Towers-March-July ore shoot which has been so extensively mined clear to the surface in the levels above.

We have 232,953 tons of ore blocked out in the Sullivan mine and 2,529,247 tons in the Bunker Hill mine. * * *

The recovery of zinc from Bunker Hill run-of-mine ore was begun in the early part of the year, and with improved facilities the rate of yield is being substantially increased. This zinc production from the Bunker Hill mine is due solely to better and more modern metallurgy and not to an increased amount of zinc in the ore.

An event of outstanding importance was the completion and successful starting of the electrolytic zinc reduction plant of the Sullivan Mining Co., owned one-half by the Bunker Hill Co. and one-half by the Hecla Mining Co. Shipments from its output of "Bunker Hill" brand slab zinc began early in November. This zinc is of unequaled purity and of a quality not heretofore available to the trade; it is being extremely well received. At this date production is at the rate of 1,500 tons per month and will be increased to 1,800 tons in due course. The zinc reduction plant has received its ore supply from a stock pile of zinc-bearing concentrates accumulated while the plant was under construction, supplemented by current production of the Sidney and Bunker Hill mines. But production from the Star mine of the Sullivan Mining Co. is now being resumed and the output from this property will eventually be the plant's chief source of supply.

The ore milled (452,345 tons) was reduced to 76,105 tons of concentrates, which contained 55.99 per cent of lead and 21.87 ounces of silver to the ton. The ratio of concentration was 5.94 to 1, and the costs per ton mined were as follows: Mining, \$3.30; concentrating, \$0.86; shipping, \$0.05; and other costs, \$0.32; a total of \$4.53. From 1886 to the end of 1928 the company mined 12,558,834 tons of ore, having a gross value of \$149,448,659. Net smelter returns were \$92,387,308, and operating profit was \$52,416,037.

The Bunker Hill smelter and refinery ran continuously in 1928, largely on ore and concentrates from the Bunker Hill and Hecla mines, but partly on custom ore from western States, Alaska, British Columbia, and South America. The output of the smelter in 1928 was 67,659 tons of lead bullion and 7,807,000 ounces of silver, compared with 69,088 tons and 5,891,000 ounces, respectively, in 1927. The construction of the new electrolytic zinc plant at Silver King was completed, and shipments of slab zinc began early in November. It is a modern electrolytic plant using the Tainton process, and the first section will produce 50 tons of zinc a day. An article ⁵ describing the process appeared in December.

The old concentrating plant on the Crescent property was destroyed by fire early in 1927; as a result, the output was unusually small. A new 120-ton flotation plant was constructed the latter part of 1927 and operated continuously in 1928 on a 12-hour basis, but no development was done in the mine. More than 15,000 tons of copper ore was treated, yielding copper concentrates valuable chiefly for the silver

⁵ Tainton, U. C., The Sullivan Electrolytic Plant: Eng. and Min. Jour., vol. 126, Dec. 1, 1928, p. 856

content. The ore contains lead, silver, copper, arsenic, antimony, and iron.

The Caledonia property was operated by lessees, who shipped 4,025 tons of silver-lead ore from old stope fillings. No development was done, and the ore body is practically exhausted. In settling the affairs of the company dividends amounting to \$390,750 were paid in 1927; no dividends were paid in 1928. According to a statement of operations for 1928 published by the company, the ore contained 122,706 ounces of silver, 30,079 pounds of copper, and 523,042 pounds of lead, which sold for \$106,463. After smelting charges of \$38,663 were deducted the company received a royalty of \$10,213.

The mill of the Constitution Mining & Milling Co. was idle most of 1928, but more than 500 tons of lead-zinc concentrates were shipped to the electrolytic plant at Great Falls, Mont. A car of first-class lead ore was also shipped to the smelter at Bradley, Idaho. The property is equipped with a 200-ton flotation plant, but separate lead and zinc products are not made. The plant is equipped with crusher, rolls, ball mill, Dorr thickener, and flotation machines. The froth from the cleaners is collective lead-zinc concentrates. The mine is developed by a main tunnel 2,508 feet long, a vertical shaft 475 feet deep, and various drifts and raises. In 1928 about 300 feet of work was done, chiefly in driving a raise from the third level to the main adit tunnel.

The Federal Mining & Smelting Co. operated the Page and Blackhawk mines, both producers of lead-zinc ore. The 300-ton flotation plant on the Page group was operated the entire year on ore from both properties, and the company shipped about 14,000 tons of lead concentrates and zinc concentrates to plants in Montana and California. The Page mine is opened by an inclined shaft 1,275 feet deep, and more than 5,600 feet of development, chiefly in drifts and raises, was done in 1928. From 84,023 tons of lead-zinc ore milled were produced lead concentrates that contained 184,105 ounces of silver and 12,108,000 pounds of lead, and zinc concentrates that contained 23.83 ounces of gold, 9,237 ounces of silver, 152,000 pounds of lead, and 2,336,000 pounds of zinc. The mine ranked fifth as a producer of lead in 1928, sixth as a producer of zinc, and eighth as a producer of silver. According to the figures given to the county assessor, the concentrates had a gross value of \$1,051,528. The cost of extraction was \$533,080, freight and treatment \$361,684, and betterment and repairs \$54,321; the net profit was \$102,443. The report of the Federal Mining & Smelting Co. gives the following notes:

Development of the Page mine during 1928 opened up the 900 level for the full length of the west ore shoot. It was found to be wider and of better grade than on the 600 level.

The ore treated contained 8.23 per cent of lead, 2.90 per cent of zinc, and 2.49 ounces of silver to the ton.

The Blackhawk mine was worked through the Page property, and 14,064 tons of lead-zinc ore was treated in the Page flotation plant. The lead concentrates contained 29,027 ounces of silver and 1,922,000 pounds of lead, and the zinc product contained 3.86 ounces of gold, 1,487 ounces of silver, 22,000 pounds of lead, and 386,000 pounds of zinc. The earnings in 1928 were \$14,043. The property is opened by 10,261 feet of workings; about 600 feet of development, chiefly in drifts, was done in 1928.

The Sidney Leasing Co. operated the Sidney mine the entire year, except when it was closed for three months on account of a fire. The company shipped more than 29,000 tons of lead-zinc ore by way of the 3½-mile aerial tramway to the Government Gulch spur of the Oregon-Washington Railroad & Navigation Co. The ore was treated at the Sweeny mill and separated by flotation into lead concentrates and zinc concentrates. The lead product was sold to the Bunker Hill smelter and the zinc concentrates were shipped for treatment in the new electrolytic zinc plant of the Sullivan Mining Co. The mine ranked third as a producer of zinc in Idaho in 1928 and tenth as a producer of lead. According to the figures given to the county assessor, 29,924 tons of ore was extracted, which had a gross value of \$123,577. The cost of extraction was \$93,868, freight and treatment \$7,540, and betterment and repairs \$3,514; the net profit was \$18,655. A royalty was paid to the Sidney Mining Co., which reported net profits of \$18,240. In 1927 the mine produced 44,180 tons of ore, which had a gross value of \$203,006; after various costs were deducted the net profit was \$52,742. The Sidney Leasing Co. paid a dividend in 1928 amounting to \$10,823. In 1927 the company paid its initial dividend of \$39,682, which makes a total of \$50,505 paid to date.

The Hayes Co. treated 33,000 tons of old creek tailings in a 100-ton flotation plant equipped with 18 Fahrenwald cells. The resulting lead concentrates are hauled 4 miles by truck to the Bunker Hill smelter. The Lookout Mountain Mining & Milling Co. used the Amy-Matchless concentration mill equipped with flotation machines and tables and treated more than 1,000 tons of lead ore. The resulting table and flotation concentrates were hauled 8 miles by truck to the smelter at Bradley.

Lessees operated in a small way the Sierra Nevada property in Government Gulch and shipped several cars of lead-zinc ore for treatment in a local custom plant; several cars of lead ore from the dump were shipped to Bradley for smelting. The Decker Development Co. operated the Stewart mine and shipped a few hundred tons of first-class sulphide lead ore. Nearly 1,000 tons of low-grade ore containing chiefly lead was also shipped from the mine dump. In 1928 the company cleaned out about 2,200 feet of old tunnels and did 600 feet of new work. The 200-ton concentration-flotation plant of the Hypotheek Mining & Milling Co. was closed in August, 1927, and has since been idle, but considerable development was done in 1928, especially on the 900-foot level.

No production was made from the Highland-Surprise mine, which is equipped with a 125-ton flotation plant, but the company did 300 feet of development work. In 1927 the mine was operated from January to April and produced lead-zinc ore, which was reduced to 300 tons of lead concentrates and 2,400 tons of lead-zinc concentrates. The mill is equipped with flotation machines, two ball mills, pumps, and Wilfley tables. Development of note was done at the Bobby Anderson, Douglas, Hilarity, King of Pine Creek, Nabob, and North Bunker Hill properties.

TWIN FALLS COUNTY

Snake River district.—A small quantity of placer gold was recovered by sluicing material from the banks of the Snake River, near Twin Falls.

VALLEY COUNTY

The value of the mine production of metals in Valley County decreased from \$3,948 in 1927 to \$3,843 in 1928. Most of the output was gold ore from the Sunnyside mine, treated by amalgamation, and placer gold from the Dewey mine, both on Thunder Mountain.

Big Creek district.—A small quantity of gold ore from the Snow Shoe mine was amalgamated and the resulting bullion sent to the assay office at Boise.

Deadwood Basin district.—A little gold was recovered from placer property near Cascade. In November the Bunker Hill & Sullivan Mining & Concentrating Co., working the Lost Pilgrim & Hall-Interstate property 54 miles from Cascade, completed a 100-ton flotation mill for the treatment of silver-copper-lead-zinc ore. The mine is opened by nearly 9,000 feet of workings; 2,469 feet of work was done in 1928. The mine will eventually be an important producer for central Idaho; the products are very rich silver-lead concentrates containing considerable copper and high-grade zinc concentrates.

Edwardsburg district.—The Smith Creek Hydraulic Mining Co. (Inc.), which owns placer property on Smith Creek and Big Creek, 40 miles east of Warren, recovered gold bullion valued at more than \$1,000 by hydraulic and sluicing operations. The company owns 565 acres of ground and has a hydraulic giant and derrick.

Hurdy Creek district.—A small quantity of gold ore from a property near Cabarton was amalgamated and the resulting bullion sent to the assay office at Boise.

Thunder Mountain district.—From August to September disintegrated ledge material from the Dewey mine on the west side of Thunder Mountain was treated in a rocker, and gold bullion having a fineness of 0.550 was sold to the assay office at Boise. At the Sunnyside mine, which is opened by about 10,000 feet of work, chiefly in drifts, 500 tons of low-grade gold ore were treated in a 10-stamp amalgamation mill, and gold bullion valued at nearly \$1,700 was sent to Boise.

WASHINGTON COUNTY

Heath district.—One car of oxidized ore assaying about 33 per cent of lead was shipped from the Galena mine, 30 miles from Council, on the Pacific & Idaho Northern Railroad. Development work in gold ore was continued at the Cuddy Mountain property, but the mill was idle.

Snake River district.—A little placer gold from the Sturgill Creek property was recovered by sluicing and sold to the assay office at Boise.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN WASHINGTON ¹

(MINE REPORT)

By C. N. GERRY ²

SUMMARY

The value of the mine production of gold, silver, copper, lead, and zinc in Washington in 1928 was 26 per cent less than that in 1927, and the output of all metals, except lead, decreased considerably. The largest decreases were in zinc from Pend Oreille County, gold and silver from Ferry County, and copper from Snohomish County. There was, however, a good increase in the output of lead from Stevens County, which offset the large decrease in lead from Pend Oreille County. The total value of the metal output of Washington in 1928 was much less than the yearly average for the decade 1919 to 1928, which was about \$860,900.

Since 1860 Washington has yielded an output of the five metals, as follows: Gold, \$30,258,099; silver, 9,204,682 fine ounces; copper, 24,248,161 pounds; lead, 61,042,141 pounds; and zinc, 12,860,408 pounds. The total value has amounted to \$46,563,027, of which 65 per cent represents the value of the gold. Dividends paid by the Lone Pine-Surprise Consolidated Mining Co. in 1928 from mining operations in the State amounted to \$62,520. No dividends were paid by the Gladstone Mountain Mining Co.

The value of the metal output of Stevens County increased more than \$5,000 because of increased shipments of lead ore from the Gladstone mine, near Northport, but large decreases in the value of the metal output were shown in Ferry, Pend Oreille, and Snohomish Counties. The value of the metal output of Ferry County, however, was nearly half the total value of the State.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

¹ Work on manuscript completed February, 1930.

² The valuable assistance of B. N. Lowry and Paul Luff, of the Bureau of Mines, is acknowledged.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in Washington, 1919-1928

Year	Mines producing		Ore and old tailings (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919.....	42	7	100,879	12,232.20	\$252,862	259,384	\$290,510
1920.....	35	9	85,318	5,846.60	120,860	199,678	217,649
1921.....	26	11	22,885	6,215.51	128,486	142,450	142,450
1922.....	33	13	36,046	9,044.43	186,965	205,046	205,046
1923.....	30	6	56,900	16,547.49	342,067	227,187	186,293
1924.....	30	4	44,383	14,977.72	309,617	213,742	143,207
1925.....	37	9	50,287	11,138.49	230,253	166,425	115,499
1926.....	49	9	54,343	9,340.82	193,092	171,649	107,109
1927.....	30	3	119,201	19,513.51	403,380	155,850	88,367
1928.....	37	1	64,554	16,310.45	337,167	99,738	58,347

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919.....	1,676,576	\$311,843	2,146,157	\$113,746	-----	-----	\$968,961
1920.....	1,983,134	364,897	5,787,247	462,980	426,496	\$34,546	1,200,932
1921.....	251,544	32,449	143,553	6,400	449,360	22,468	332,313
1922.....	317,203	42,822	1,381,199	75,966	1,228,229	70,009	580,808
1923.....	871,999	128,184	2,906,479	203,454	3,024,535	205,668	1,065,666
1924.....	928,458	121,628	3,935,376	314,830	910,890	59,208	948,490
1925.....	1,159,057	164,586	5,627,241	489,570	1,217,846	92,556	1,092,464
1926.....	1,351,890	189,265	4,546,228	363,698	1,044,354	78,327	931,491
1927.....	1,685,848	220,846	955,003	60,165	1,279,710	81,901	854,659
1928.....	1,177,246	169,523	1,084,739	62,915	85,318	5,204	633,156

Gold and silver produced at placer mines in Washington, 1919-1928, in fine ounces

Year	Gold	Silver	Year	Gold	Silver
1919.....	60.32	18	1924.....	33.77	12
1920.....	71.20	16	1925.....	52.87	11
1921.....	148.66	48	1926.....	1,354.50	456
1922.....	162.44	49	1927.....	18.82	5
1923.....	73.09	23	1928.....	90.85	30

GOLD

The mine production of gold in Washington in 1928 decreased more than 16 per cent compared with 1927, because of the large decreases in the output of Ferry and Whatcom Counties. The large decrease in the output of gold was due chiefly to the fact that the Consolidated Mining & Smelting Co. of Canada (Ltd.), at Trail, British Columbia, refused to receive shipments of siliceous ore from the mines at Republic, Ferry County, after October. Ore shipped direct to smelters yielded 77 per cent of the total gold, and ore and

old tailings amalgamated yielded nearly 22 per cent. About 77 per cent of the total gold was recovered from gold ore from mines at Republic, Ferry County, and nearly all the remainder came from gold ore from the Boundary Red Mountain mine, in Whatcom County. The chief producers of gold were the Quilp mine, at Republic; the Boundary Red Mountain mine, in Whatcom County; and the Aurum group (Surprise, Lone Pine, V Fraction, and Pearl claims), at Republic. The Last Chance and Insurgent mines, at Republic, also produced considerable gold. There will be a marked decrease in the output of gold in Washington in 1929, as all the large producers of siliceous gold ore at Republic were idle at the beginning of the year.

SILVER

The mine production of silver in Washington in 1928, most of which came from the Republic district, Ferry County, decreased 36 per cent in quantity compared with 1927; it was the smallest output since 1909. A decrease of 49,665 ounces was recorded in the output of Ferry County, but a slight increase was recorded in Stevens County. Crude ore shipped to smelters yielded nearly 89 per cent of the total silver and concentrates nearly all the remainder. Gold ore and old tailings yielded more than 65 per cent of the total silver, copper ore 23 per cent, and silver ore and lead ore 10 per cent. The Aurum group (Surprise, Lone Pine, V Fraction, and Pearl claims) was the largest producer of silver, followed by the Last Chance and Quilp mines, all at Republic; the Chewelah Union property, at Chewelah, and the Sunset mine, near Index, also produced much silver.

COPPER

The mine production of copper in Washington in 1928 decreased 30 per cent in quantity compared with 1927 but was more than the annual average output for the decade 1919 to 1928, which was 1,140,300 pounds. Most of the copper produced in 1928 resulted from milling operations at the Sunset mine, near Index, Snohomish County; the output decreased 32 per cent compared with that of 1927. A little crude copper ore was shipped from Index and Wayside, Snohomish County; Chewelah, Stevens County; and Glacier Basin, Pierce County.

LEAD

The mine production of lead in Washington in 1928 increased nearly 14 per cent in quantity compared with 1927 as a result of an increase in the output of lead from the Gladstone mine, near Northport, Stevens County. This mine was the largest producer of lead in Washington in 1928, and its output was more than double that of 1927. The Electric Point mine, also near Northport, was the only other large producer of lead. In 1926, when the Gladstone mine produced heavily, the mines of Washington produced 4,546,228 pounds of lead.

ZINC

The mine production of zinc in Washington in 1928, the smallest output since 1919, decreased more than 93 per cent in quantity compared with 1927. This large decrease was due chiefly to the inactivity

of the flotation mill of the Pend Oreille Lead & Zinc Co., near Metaline Falls, Pend Oreille County; there was also a large decrease in the output of zinc from the Black Rock mine, near Northport, Stevens County. There were only three producers of zinc in Washington in 1928—the Black Rock mine, the Lucille mine, and the Great Western property, all near Northport, Stevens County.

Mine production of gold, silver, copper, lead, and zinc in Washington in 1928, by counties

County	Gold (lode and placer)		Silver (lode and placer)	
	Fine ounces	Value	Fine ounces	Value
Ferry.....	12, 519.35	\$258, 798	65, 198	\$38, 141
Kittitas.....	90.85	1, 878	30	18
Okanogan.....	44.41	918	185	108
Pend Oreille.....	1.02	21	721	422
Pierce.....			17	10
Skagit.....	.10	2	56	33
Snohomish.....	113.00	2, 336	10, 951	6, 406
Stevens.....	39.18	810	22, 398	13, 103
Whatcom.....	3, 502.54	72, 404	182	106
Total, 1927.....	16, 310.45	337, 167	99, 738	58, 347
	19, 513.51	403, 380	155, 850	88, 367

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Ferry.....							\$296, 939
Kittitas.....							1, 896
Okanogan.....			46	\$3			1, 029
Pend Oreille.....	11, 047	\$1, 591	55, 085	3, 195			5, 229
Pierce.....	1, 552	223					233
Skagit.....	34	5	1, 281	74			114
Snohomish.....	1, 090, 748	157, 068					165, 810
Stevens.....	73, 865	10, 636	1, 028, 327	59, 643	85, 318	\$5, 204	89, 396
Whatcom.....							72, 510
Total, 1927.....	1, 177, 246	169, 523	1, 084, 739	62, 915	85, 318	5, 204	633, 156
	1, 685, 848	220, 846	955, 003	60, 165	1, 279, 710	81, 901	854, 659

Ore and old tailings sold or treated, lode mines producing, and average value of ore and old tailings in gold and silver in Washington, 1927-28, by counties

County	Ore and old tailings (short tons)		Lode mines producing		Average value per ton in gold and silver	
	1927	1928	1927	1928	1927	1928
Chelan.....	10		2		\$42. 70	
Ferry.....	36, 945	28, 978	7	8	10. 20	\$10. 25
King.....	25		1		38. 28	
Okanogan.....		39		3		26. 31
Pend Oreille.....	35, 348	700	4	1	. 05	. 63
Pierce.....	47	12	1	2	1. 81	. 83
Skagit.....		5		1		7. 00
Snohomish.....	37, 097	27, 925	2	2	. 34	. 31
Stevens.....	3, 267	2, 145	12	19	3. 51	6. 49
Whatcom.....	6, 462	4, 750	1	1	13. 46	15. 27
	119, 201	64, 554	30	37	4. 12	6. 10

MINING INDUSTRY

Despite the fact that the mining industry in Washington in 1928 was active in prospecting, development, and construction work, the production of gold, silver, copper, and zinc was considerably less than that in 1927. The production of lead, although somewhat greater than in 1927, was less than one-fourth that in 1926. The output of siliceous gold ore was seriously affected by an order from the smelting company at Trail, British Columbia, to stop shipments from Republic in October. There was some consolation in the fact that progress was made in the development of copper ore in Chelan County and lead-zinc ore near Metaline Falls, Pend Oreille County. Several new milling plants were completed, and a large flotation mill was planned for lead-zinc ore.

ORE CLASSIFICATION

Ore and old tailings sold or treated in Washington, 1919-1928, with content in terms of recovered metals

DRY AND SILICEOUS ORE

Year	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	29,086	12,016.93	104,980	2,463	143	-----
1920.....	13,096	5,549.82	45,977	2,073	1,743	-----
1921.....	20,199	6,015.38	68,991	3,293	3,339	-----
1922.....	24,782	8,830.87	106,243	2,189	17,759	-----
1923.....	33,499	16,348.92	127,029	349	4,467	-----
1924.....	17,575	14,706.15	70,178	510	-----	-----
1925.....	15,383	10,876.19	43,083	16	-----	-----
1926.....	17,599	7,707.83	56,556	522	-----	-----
1927.....	43,450	19,342.20	115,684	53	1,929	-----
1928.....	33,956	16,098.60	70,191	121	1,911	-----

COPPER ORE

1919.....	68,447	153.01	146,891	1,669,060	-----	-----
1920.....	62,814	223.59	146,820	1,975,604	-----	-----
1921.....	1,332	24.91	65,716	246,017	-----	-----
1922.....	6,086	38.40	68,239	312,912	239	-----
1923.....	11,128	80.01	60,805	855,152	-----	-----
1924.....	15,916	117.70	44,173	927,407	-----	-----
1925.....	19,500	139.80	37,131	1,158,812	-----	-----
1926.....	25,297	190.98	18,456	1,348,545	-----	-----
1927.....	37,564	139.00	35,926	1,684,450	-----	-----
1928.....	28,560	117.00	22,937	1,165,342	-----	-----

LEAD ORE

1919.....	3,281	1.60	5,251	1,028	2,118,886	-----
1920.....	8,660	1.99	4,123	-----	5,753,976	-----
1921.....	354	26.56	7,695	2,234	136,974	-----
1922.....	3,624	12.72	30,463	2,102	1,363,201	-----
1923.....	7,881	43.44	36,819	1,341	2,859,032	-----
1924.....	8,111	120.10	99,300	541	3,916,260	-----
1925.....	11,518	57.43	77,618	24	5,591,348	-----
1926.....	7,659	75.27	82,733	2,823	4,450,458	-----
1927.....	1,648	7.26	1,939	270	824,423	-----
1928.....	887	2.48	5,414	681	1,004,399	-----

COPPER-LEAD ORE

1919.....	65	0.34	2,244	4,025	27,128	-----
1920.....	90	-----	2,742	5,457	25,708	-----
1921-22.....	-----	-----	-----	-----	-----	-----
1923.....	942	2.03	2,511	15,157	42,980	-----
1924-27.....	-----	-----	-----	-----	-----	-----
1928.....	700	1.00	721	11,047	55,085	-----

Ore and old tailings sold or treated in Washington, 1919-1928, with content in terms of recovered metals—Continued

ZINC ORE AND LEAD-ZINC ORE

Year	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....						
1920.....	658				5,820	426,496
1921.....	1,000				3,240	449,360
1922.....	1,554		52			1,228,229
1923.....	3,450					3,024,535
1924.....	2,781		79		19,116	910,890
1925.....	3,886	12.20	8,582	205	35,893	1,217,846
1926.....	3,788	12.24	13,448		95,770	1,044,354
1927.....	36,539	6.23	2,296	1,075	128,651	1,279,710
1928.....	451	.52	445	55	23,344	85,318

Ore and old tailings sold or treated in Washington in 1928, with content in terms of recovered metals

Source	Mines producing	Ore and old tailings		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore.....	13	¹ 33,898	52.51	16,097.84	98.70	65,421	65.59
Dry silver ore.....	4	58	.09	.76		4,770	4.78
Copper ore.....	6	28,560	44.24	117.00	.72	22,937	23.00
Lead ore.....	10	887	1.37	2.48	.02	5,414	5.43
Zinc ore.....	1	350	.54				
Lead-zinc ore.....	2	101	.16	.52		445	.45
Copper-lead ore.....	1	700	1.09	1.00		721	.72
Total, lode mines.....	² 37	64,554	100.00	16,219.60	99.44	99,708	99.97
Total, placers.....	1			90.85	.56	30	.03
Total, 1927.....	38	64,554	100.00	16,310.45	100.00	99,738	100.00
	33	119,201		19,513.51		155,850	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore.....						
Dry silver ore.....	121		1,911	0.18		
Copper ore.....	1,165,342	98.99				
Lead ore.....	681	.07	1,004,399	92.59		
Zinc ore.....					55,731	65.32
Lead-zinc ore.....	55		23,344	2.15	29,587	34.68
Copper-lead ore.....	11,047	.94	55,085	5.08		
	1,177,246	100.00	1,084,739	100.00	85,318	100.00
Total, 1927.....	1,685,848		955,003		1,279,710	

¹ Includes 130 tons of old tailings amalgamated.

² A mine producing more than one class of ore is counted but once in arriving at total for all classes.

Value of metals from ore and old tailings sold or treated in Washington in 1928, by kinds of ore

Kind of ore	Ore and old tailings (short tons)	Gold	Silver	Copper	Lead	Zinc	Total
Dry gold ore.....	33,898	\$332,772	\$38,271				\$371,043
Dry silver ore.....	58	16	2,791	\$17	\$111		2,935
Copper ore.....	28,560	2,418	13,418	167,809			183,645
Lead ore.....	887	51	3,167	98	58,255		61,571
Zinc ore.....	350					\$3,399	3,399
Lead-zinc ore.....	101	11	260	8	1,354	1,805	3,438
Copper-lead ore.....	700	21	422	1,591	3,195		5,229
Total, 1927.....	64,554	335,289	58,329	169,523	62,915	5,204	631,260
	119,201	402,991	88,364	220,846	60,165	81,901	854,267

DRY AND SILICEOUS ORE

The gold ore and old tailings in 1928, as for several years past, were largely siliceous smelting ore mined at Republic; the output decreased 22 per cent from that of 1927. The largest producer of gold ore was the Quilp mine, followed by the Aurum group. The total value of metals recovered from gold ore and old tailings was \$371,043; the material averaged \$9.82 in gold and 1.93 ounces of silver to the ton.

A small quantity of silver ore was marketed in 1928, but no gold and silver ore was produced. Most of the silver ore came from the Silver Queen property, near Miles, Stevens County.

COPPER ORE

Copper ore yielded metals valued at \$183,645 in 1928; the ore averaged 8 cents in gold and 0.80 ounce of silver to the ton and 2.04 per cent of copper. Nearly all the copper ore came from Index, Snohomish County; it was largely milling ore. Copper ore from the old Turk mine, near Fruitland, was also milled, and several cars of copper concentrates were shipped.

LEAD ORE

The metals recovered from lead ore were valued at \$61,571. Most of the ore came from the Gladstone Mountain mine, near Northport, Stevens County; it yielded on the average 6 cents in gold and 6.10 ounces of silver to the ton, 56.62 per cent of lead, and a little copper.

ZINC ORE

The metals recovered from zinc ore were valued at \$3,399. All this material came from property near Northport, Stevens County, and was of milling grade. The total milling ore averaged 8.63 per cent of recoverable zinc.

LEAD-ZINC ORE

The lead-zinc ore—101 tons—yielded on the average 4.41 ounces of silver to the ton, 11.56 per cent of lead, and 14.65 per cent of zinc; it all came from two mines near Northport, and about half of it was shipped to an eastern zinc plant.

COPPER-LEAD ORE

The metals recovered from copper-lead ore were valued at \$5,229; the ore yielded on the average 1.03 ounces of silver to the ton, 0.79 per cent of copper, and 3.93 per cent of lead. It was shipped from the Newport district, Pend Oreille County.

Ore and old tailings sold or treated in Washington in 1928, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore and old tailings	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Ferry.....	28, 978	12, 519. 34	65, 198	-----	-----	-----
Okanogan.....	38	43. 83	13	-----	-----	-----
Stevens.....	¹ 132	32. 14	28	-----	-----	-----
Whatcom.....	4, 750	3, 502. 53	182	-----	-----	-----
Total, 1927.....	33, 898 43, 442	16, 097. 84 19, 342. 06	65, 421 115, 391	53	1, 354	-----

COPPER ORE

Pierce.....	12	-----	17	1, 552	-----	-----
Snohomish.....	27, 925	113. 00	10, 951	1, 090, 748	-----	-----
Stevens.....	623	4. 00	11, 969	73, 042	-----	-----
Total, 1927.....	28, 560 37, 564	117. 00 139. 00	22, 937 35, 926	1, 165, 342 1, 684, 450	-----	-----

LEAD ORE

Skagit.....	5	0. 11	56	34	1, 281	-----
Stevens.....	882	2. 37	5, 358	647	1, 003, 118	-----
Total, 1927.....	887 1, 648	2. 48 7. 26	5, 414 1, 939	681 270	1, 004, 399 824, 423	-----

ZINC ORE

Stevens.....	350	-----	-----	-----	-----	55, 731
Total, 1927.....	350 35, 307	----- 6. 23	----- 2, 134	----- 1, 075	----- 37, 788	55, 731 1, 211, 152

LEAD-ZINC ORE

Stevens.....	101	0. 52	445	55	23, 344	29, 587
Total, 1927.....	101 1, 232	. 52 -----	445 162	55 -----	23, 344 90, 863	29, 587 68, 558

¹ Includes 130 tons of old tailings amalgamated.

Lead-zinc ore and zinc concentrates (as marketed from Washington mines and mills) sold to smelters in 1928

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of ore or concentrates	Recovered zinc
		<i>Short tons</i>	<i>Pounds</i>	<i>Per cent</i>	<i>Pounds</i>
Oxidized lead-zinc ore.....	Stevens.....	45	28, 320	31. 47	22, 656
Zinc concentrates.....	do.....	62	68, 093	54. 91	62, 662
		107	96, 413	45. 05	85, 318

METALLURGIC INDUSTRY

Of the total ore and old tailings from Washington treated in 1928, more than 7 per cent was ore and old tailings amalgamated (nearly all from the Boundary Red Mountain mine in Whatcom County),

more than 45 per cent was ore concentrated, and 47 per cent was crude ore shipped for smelting.

Six milling plants in Washington were active in 1928. Two used table concentration, two a combination of flotation and table concentration, and two amalgamation.

Ore and concentrates from mines in Washington were smelted mainly at Bradley, Idaho, Tacoma, Wash., and Trail, British Columbia. Lead ore and concentrates were smelted at the Bunker Hill plant at Bradley, Idaho; copper material at Tacoma, Wash.; and siliceous ore at Trail, British Columbia. Zinc concentrates were roasted and leached near Great Falls, Mont., and lead-zinc ore was shipped to Mineral Point, Wis., and Trail, British Columbia. An unusually complete plant for milling, smelting, and refining was operated at Trail, British Columbia. The Consolidated Mining & Smelting Co. of Canada (Ltd.) treated company ore and custom material, all refining being done locally.

The ore concentrated yielded 1,886 tons of concentrates, most of which was copper concentrates and nearly all the remainder zinc and copper-lead concentrates.

Nearly all the ore shipped crude to smelters was gold ore from Ferry County. The output of first-class lead ore decreased slightly, and the output of siliceous ore decreased more than 21 per cent from that of 1927.

Gross metal content of Washington concentrates produced in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
		<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Copper.....	<i>Short tons</i> 1,748	105.00	10,162	1,117,199		
Zinc.....	54					60,380
Lead-zinc.....	14	.32	184		6,379	7,713
Copper-lead.....	70	1.00	721	13,809	57,984	
	1,886	106.32	11,067	1,131,008	64,363	68,093

Mine production of metals from Washington concentrates in 1928

BY COUNTIES

County	Ore and old tailings to concentrating mills		Concentrates and recovered metal					
	Ore	Old tailings	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Pend Oreille.....	700		70	1.00	721	11,047	55,085	
Snohomish.....	27,729		1,646	104.00	10,090	1,044,969		
Stevens.....	889		170	1.32	256	38,714	6,061	62,662
Total, 1927.....	29,318		1,886	106.32	11,067	1,094,730	61,146	62,662
	64,875	9,537	4,401	141.03	19,939	1,599,512	275,260	1,252,870

BY KINDS OF CONCENTRATES

Copper.....		1,748	105.00	10,162	1,083,683		
Lead.....		6	.32	143		5,806	
Zinc.....		62		41		255	62,662
Copper-lead.....		70	1.00	721	11,047	55,085	

Gross metal content of Washington crude ore shipped to smelters in 1928

Class of ore	Quantity (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous	29, 075	12, 560. 65	69, 988	201	2, 010	-----
Copper	331	12. 00	12, 775	84, 185	-----	-----
Lead	887	2. 48	5, 414	1, 121	1, 057, 419	-----
Lead-zinc	62	. 20	261	69	20, 109	28, 320
	30, 355	12, 575. 33	88, 438	85, 576	1, 079, 538	28, 320

Mine production of metals from Washington crude ore shipped to smelters in 1928

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Ferry	28, 978	12, 519. 34	65, 198	-----	-----	-----
Okanogan	38	37. 73	183	-----	46	-----
Pierce	12	. 11	17	1, 552	-----	-----
Skagit	5	. 11	56	34	1, 281	-----
Snohomish	196	9. 00	861	45, 779	-----	-----
Stevens	1, 126	9. 15	22, 123	35, 151	1, 022, 266	22, 656
	30, 355	12, 575. 33	88, 438	82, 516	1, 023, 593	22, 656
Total, 1927	38, 321	15, 143. 14	135, 684	86, 336	679, 743	26, 840

BY KINDS OF ORE

Dry and siliceous	29, 075	12, 560. 65	69, 988	121	1, 911	-----
Copper	331	12. 00	12, 775	81, 659	-----	-----
Lead	887	2. 48	5, 414	681	1, 004, 399	-----
Lead-zinc	62	. 20	261	55	17, 283	22, 656

REVIEW BY COUNTIES AND DISTRICTS

As the detailed review of the districts was omitted from the report of this series for 1927, the production of the important districts for that year has been inserted in the following review.

CHELAN COUNTY

Blewett or Peshastin district.—A steam shovel with other equipment was installed at the Daisy placer property on Peshastin Creek, near Dryden.

Leavenworth district.—The Royal Development Co., operating property on Red Mountain, continued doing important development in opening copper ore through the Trinity tunnel. The tunnel was driven 2,440 feet in 1928, making a total length of 10,685 feet. A summary of the work was published in *Mining Truth*.³ The Trinity tunnel is said to have penetrated the hanging wall of the St. Francis ore body, cutting 60 feet of commercial ore. The St. Francis tunnel is approximately 900 feet above the Trinity tunnel.

³ *Mining Truth*, Royal Development Cuts Big Ore Zone: Nov. 16, 1928, p. 6.

FERRY COUNTY

Enterprise or Covada district.—Work at the Cuba property consisted chiefly of surface improvements. A car of silver-lead ore was sorted from the dumps but not shipped.

Keller district.—A flotation plant is planned for the Addison property, 28 miles north of Wilbur; 210 feet of development was done and new buildings were erected in 1928.

Republic district.—In 1928 eight lode mines in the Republic district produced 28,978 tons of ore, yielding \$258,798 in gold and 65,198 ounces of silver, valued together at \$296,939, or \$10.25 in metals a ton. In 1927 the Republic district produced 36,945 tons of ore, which yielded \$311,805 in gold and 114,863 ounces of silver, valued together at \$376,932. The marked decrease in the output of the district in 1928 was due in part to the exhaustion of the ore body in the Last Chance mine and to the fact that ore shipments from the district are restricted by the Consolidated Mining & Smelting Co. of Canada (Ltd.), Trail, British Columbia, which takes the entire output of siliceous ore from the mines at Republic. As usual, the output in 1928 consisted of siliceous ore, containing gold and silver, which is used as a smelting flux at Trail, British Columbia. From 1896 to the end of 1928 the district produced 703,914 tons of ore and old tailings, yielding \$8,636,616 in gold and 2,570,623 ounces of silver, valued together at \$10,253,007. The largest producer of the district in both 1927 and 1928 was the Quilp mine, which in 1928 shipped more than 14,000 tons of siliceous ore for smelting. This ore represented the output of nine months, as the Consolidated Mining & Smelting Co. of Canada (Ltd.) needed no siliceous ore after October 18. The ore broken in the mine was cleaned up and the mine closed early in December. The next largest production was that of the Aurum Mining Co., operating the Surprise-Lone Pine-Pearl group and the V Fraction property. This group, formerly worked by the Northport Smelting & Refining Co., increased its output of siliceous ore from 6,000 tons in 1927 to more than 9,000 tons in 1928. A large part of the output was produced as usual from the Surprise property, and part of it was ore of good grade from the V Fraction property. The Last Chance mine of the Lone Pine-Surprise Consolidated Mining Co. produced more than 2,700 tons of siliceous gold ore during the first half of the year. The known ore in the deposit was practically exhausted before the smelting company restricted shipments. The mining company did 935 feet of drifting and crosscutting. In recent years the Last Chance mine has been one of the chief producers in the Republic district. In 1928 the company paid dividends amounting to \$62,520—the only dividend paid by a metal-mining company in Washington for the year. The company also shipped 1,600 tons of siliceous ore from the Insurgent property under lease, but the lease was surrendered July 1 as shipments were no longer profitable. The Mountain Lion mine, an old producer, was operated intermittently, and a few hundred tons of siliceous ore was shipped for smelting. One car of rather high-grade ore was shipped from the Morning Glory property, two lots were shipped from the California mine, and a test lot of high-grade ore was shipped while prospecting stringers of ore in the Opal property, two miles west of Republic. No ore was shipped from the old Republic mine, but a 3-foot ledge of gold-silver ore was opened early in 1929. There will

be a serious decrease in the output of gold in Ferry County in 1929, as all the large producers of siliceous gold ore at Republic were idle at the beginning of the year.

KING COUNTY

Miller River district.—A crosscut tunnel 940 feet long was driven at the Apex property of the National Gold Corporation in opening at depth several veins containing gold ore of good grade.

KITTITAS COUNTY

Swauk district.—The Kittitas Gold Mining Co., which owns an electric dredge equipped with 62 buckets, each having a capacity of 7½ cubic feet, was practically idle as the dredging plant was being moved to new ground in Deer Gulch. The dredge operated a few days, and some gold bullion was deposited at the Seattle assay office. It is probable that regular production will be made in 1929 as the company produced bullion valued at more than \$27,000 in 1926.

OKANOGAN COUNTY

Little mining was done in Okanogan County in 1928. One car of gold ore was shipped by lessees from the Gold Axe property, in the Meyers Creek district; a sample lot of silver ore was marketed from the Nespelem region; and a small lot of rich gold ore was shipped from the Twisp district.

The levels of the Alder group of the Alder Metals Corporation in the Twisp district were cleaned out and numerous samples taken, which suggest the possibility of opening considerable gold-silver-copper ore with further development. Work was continued at the Kaaba and Silver-Lead properties in the Palmer Mountain district and at the copper property of the Methow Mining & Smelting Co., near Methow.

PEND OREILLE COUNTY

The value of the metal output of Pend Oreille County decreased from \$80,285 in 1927 to \$5,229 in 1928. The largest decrease was in the output of zinc; it resulted from the idleness of the flotation mill of the Pend Oreille Lead & Zinc Co., at Metaline Falls. There was also a large decrease in the output of lead.

Metaline district (Metaline Falls).—Considerable work was done in development, testing ground, and mill building in the Metaline district in 1928, but no ore was milled or shipped from this section. The district was a fairly important producer in 1927, when four lode mines produced 35,348 tons of ore and old tailings, yielding \$228 in gold, 2,913 ounces of silver, 1,075 pounds of copper, 290,861 pounds of lead, and 936,576 pounds of zinc, valued in all at \$80,285, or \$2.27 in metals a ton. Most of the ore and old tailings was concentrated in the 200-ton flotation mill of the Pend Oreille Lead & Zinc Co. In 1928 a 1,000-foot haulage tunnel was driven at the Grandview property, and considerable churn drilling was done to test the ground. No mining or milling was done, but the Z-Canyon property was acquired and a 250-ton flotation mill was constructed, which began operations early in 1929. The Pend Oreille Lead & Zinc Co. did 3,000 feet of

diamond drilling in testing the deposit at the Lead King property and 20,000 feet of diamond and churn drilling and 750 feet of drifting and crosscutting in the Hortense, Josephine, Oriole, and Sullivan groups. The 200-ton milling plant was idle, but plans were drawn early in 1929 for a new flotation mill and an electrolytic plant. Development continued at the Belle of May property, and a 100-ton flotation mill was under construction.

Newport district.—The Bead Lake Mining Co., which owns the Comstock and Conquest claims, was closed in 1928 and the company was in the hands of a receiver; two cars of copper-lead concentrates, possibly from former operations of the 100-ton concentrator, were shipped for smelting.

PIERCE COUNTY

The American Smelting & Refining Co. continued to operate its copper smelter and refinery at Tacoma. Comparatively little ore was received from mining camps in Washington. Most of the charge came from mines in Alaska, British Columbia, and South America. Washington has had no lead smelter since the plant at Northport was dismantled and had no zinc smelter or electrolytic plant in 1928; it is planned, however, to construct an electrolytic refinery soon. Copper ore from Chewelah or eastern points must be shipped to the west coast, whereas lead products go a comparatively short distance to Bradley, Idaho, and siliceous ore goes to Trail, British Columbia.

Glacier Basin district.—A test lot of copper ore was shipped from the Mount Rainier property, 48 miles from Enumclaw, on the White River. The company is now driving a 1,500-foot tunnel to tap the ore at an elevation of about 6,000 feet. Ore shipped in the past was mined from an upper level at an elevation of 7,600 feet.

Mount Rainier district.—A test lot of copper ore mined from the Eagle Peak prospect was shipped from Ashford on the Chicago, Milwaukee, St. Paul & Pacific Railroad.

SKAGIT COUNTY

Thunder Creek district.—One test lot of silver-lead ore was shipped by the Cascade Minerals Corporation from property near Rockport. Tunnel work is said to have opened about 40,000 tons of ore, and the company is building a road from the mine to Diablo, a station on the Great Northern Railroad.

SNOHOMISH COUNTY

Index district.—The Sunset Copper Co., near Index, was as usual the largest producer of copper in Washington, but the quantity of ore milled in 1928 was about 27 per cent less than that treated in 1927. The chief production is mixed flotation and table concentrates containing gold, silver, and copper. About 600 feet of development was done in 1928, and the 150-ton concentration mill was operated only on a 2-shift basis as work was interrupted on account of insufficient water. The mill is equipped with a Blake crusher, gyratory crusher, rolls, ball mill, tables, flotation machines, and an Oliver filter. In 1927 the company treated about 37,000 tons of copper ore containing chiefly chalcopyrite and bornite. The mill feed is said to contain 2.5 per cent of copper, and the recovery is 95 per cent in

copper concentrates; the concentrates average from 30 to 35 per cent copper. The cost of mining and milling is said to be \$3.40 a ton. An article⁴ issued early in 1927 describes the conditions at the mine and mill.

Stilaguamish district.—The Riverside Minerals Co. shipped one car of copper ore from the Wayside mine, near Granite Falls, and a little tunnel work was done at the Yankee Boy property.

STEVENS COUNTY

The value of the mine production of metals in Stevens County was \$89,396 in 1928, or \$5,056 more than in 1927. The increase in the output of lead offset the decrease in the output of zinc. There were also increases in the output of gold, silver, and copper. The Gladstone Mountain mine, near Northport, was the largest producer in the county, but the output was small compared with that of 1925 and 1926.

Bossburg district.—The Young America mine, owned by the Cuprite Mining Co., was operated by lessees, who shipped 17 tons of silver-lead ore to the Bunker Hill smelter at Bradley, Idaho. About 80 feet of tunnel work was done in 1928, and silver-lead ore of good grade was opened early in 1929.

Chewelah district.—The United Copper group northwest of Chewelah was a large producer of silver and copper from 1912 to 1923. The property is now owned by the Chewelah Union Mining Co. but was operated only by lessees in 1928. Five cars of silver-copper ore were shipped to Tacoma for smelting, for which the smelter paid \$9,727. The shipments averaged about 96 ounces of silver to the ton and about 14 per cent of copper.

Colville and Clugsten Creek district.—There were no shipments of importance in 1928 from the vicinity of Colville. A small lot of oxidized lead ore from the Neglected mine and some magnesium limestone from the Dolomite quarry were shipped. The Dominion Silver-Lead Mining Co., the largest producer in the district in 1925, was idle except for slight development under lease. The opening of silver-lead-zinc ore was reported at both the Chloride Queen and the property of the American Concentrating Mining Co.

Loon Lake district.—The Loon Lake mine, an old producer of copper ore, was reopened by the Loon Lake Copper-Silver Corporation.

Northport district.—In 1928 nine lode mines in the Northport district produced 1,284 tons of ore, yielding \$16 in gold, 3,068 ounces of silver, 583 pounds of copper, 1,006,732 pounds of lead, and 85,318 pounds of zinc, valued in all at \$65,490, or \$51 in metals a ton. The larger part of the ore, or 895 tons, was first-class smelting ore, and the remainder was zinc and lead-zinc ore concentrated. In 1927 six lode mines produced 2,810 tons of ore, which yielded metals valued at \$63,521, or \$22.61 in metals a ton. From 1923 to 1928 the Gladstone Mountain property was the leading producer of lead in Washington, but since 1927 marked curtailment in shipments from the property has seriously decreased the value of the district output. The Gladstone Mountain Mining Co. operated its property until June, when it was taken over by lessees. About 300 feet of development was done, and more than 600 tons of lead ore, chiefly sulphide

⁴ Johanson, N. E., The Sunset Mine in Washington: Eng. and Min. Jour., vol. 120, Jan. 29, 1927, p. 212.

material, was shipped to Bradley, Idaho, for smelting. No dividends were distributed in 1928; the company paid \$39,657 in 1927. A total of \$198,284 has been paid to date. The Black Rock mine of the Washington Black Rock Mining Co. was also operated by lessees, and zinc ore was treated in a small concentration mill at Northport. More than 500 feet of development was done in drifting and shaft sinking, but the output in 1928 was small compared with the past production.

The Electric Point mine was operated for a short time by lessees, who shipped several cars of lead ore to the Bunker Hill smelter at Bradley, Idaho. This mine was a large producer of lead ore from 1916 to 1927. The remainder of the district output in 1928 consisted of small shipments of lead ore and lead-zinc ore from the Lucille, Great Western, Red Top, Morning, and Progress properties. One small lot of high-grade silver ore was shipped from the property of the White City Silver Mines Co., incorporated late in 1928. Work at the Red Top property consisted of 800 feet of tunneling, raising, and shaft sinking.

Orient district.—The output of the Orient district consisted of a small test lot of gold ore from the Swamp Queen property and a shipment of gold bullion from the treatment of old tailings at the Eldorado property. As in past years, magnetic iron ore from the Big Iron deposit was shipped to the Northwest Magnesite Co. at Chewelah, Wash.

Springdale district.—Five lode mines in the Springdale district produced 585 tons of ore, yielding \$43 in gold, 6,166 ounces of silver, 38,954 pounds of copper, and 7,780 pounds of lead, valued in all at \$9,710, or \$16.60 in metals a ton. Shipments of silver ore were made from the Silver Queen and Giant Silver properties; several cars of copper concentrates were shipped from the Turk property by the Snowdrift Mining Co.; and one car of rich silver ore was marketed by the Venus Silver Mines Co. The Venus company was engaged in building a 100-ton plant equipped for flotation and cyanidation to treat what is reported to be a large quantity of ore both in the mine and on the dump. Much development was reported from the Orazada property in opening silver-lead ore. Development was progressing at the Aichan Bee and Standard properties.

Summit district.—The Consolidated Silver Mountain Mines Co. has developed considerable silver-lead-zinc-arsenic ore at its property at Daisy. The mine is equipped with a reduction plant, still in the experimental stage, employing gravity concentration followed by a small blast furnace, the fumes from which will be treated in a muffle furnace.

WHATCOM COUNTY

Mount Baker district.—The Boundary Red Mountain mine south of Sardis, British Columbia, was operated under lease in 1928 and produced gold bullion valued at nearly \$62,000, compared with about \$87,000 in 1927. The ore is treated in a 10-stamp amalgamation mill, which was operated on a 10-hour basis for nine months in 1928. Development consisted of 300 feet of drifts and 200 feet of raises. The Brooks-Willis Metals (Inc.) made general improvements in preparation for mining and milling in 1929. The mine, which is near Glacier, is equipped with a 75-ton amalgamation mill.

COPPER ¹

BY C. E. JULIHN and H. M. MEYER ²

INTRODUCTION

It is less true than formerly that the production of copper requires three operations—mining, smelting, and refining. All copper must be mined; but for years some Lake Superior copper has been smelted and sold as Lake copper without subsequent refining, and a steadily increasing amount of copper is being extracted from ores by leaching methods, which render smelting unnecessary. Nevertheless, it is still practicable to determine the copper production of the United States by three distinct sets of statistics which may be obtained, respectively, from the mines, the smelters, and the refineries.

These separate determinations of production are desirable because each of them has for certain purposes a particular advantage over the others. As they show different aspects of production, the three sets of figures will never agree exactly, but, taken together, they afford complete data on the output of copper.

Details of the geographic distribution of output are shown more precisely by statistics of mine production than by those of smelter and refinery production. Likewise, the character of the ores produced, their contents of copper and other valuable metals, and the treatment, other than smelting, they may have undergone can be learned accurately only from the mines themselves. On the other hand, mine statistics show only the estimated recoverable metal content of the ores.

The actual percentage of crude copper recovered from copper ores and from other ores having a low content of copper is shown by the smelter statistics. Lead and zinc ores, siliceous ores of the precious metals, and pyrite roasted in the manufacture of sulphuric acid often carry so little copper that the mines are not paid for it and do not report it, although these sources as a whole yield a considerable amount of copper. Another cause of difference between the figures of mine and of smelter production is the lag in time between the production and the smelting of an ore. For example, most of the ore mined in December of any year is not represented in the figures of smelter production for that year but enters into the figures of the year following. A third cause of difference between these two sets of figures is that the amount of metal contained in ore, matte, and other material held in stock at smelters is rarely the same at the beginning and the end of a year. Smelter statistics, as well as mine statistics, show broadly the geographic distribution of output.

The precise amount of copper made available for consumption in a given period, as well as that of the precious metals recovered from crude copper, is shown only by refinery statistics; but these afford little information on the distribution of output according to source

¹ Work on manuscript completed February, 1930.

² Figures on imports and exports compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

and are uncertain even in their classification of the material refined as foreign or domestic.

Differences between smelter and refinery statistics are similar in origin to those existing between mine and smelter statistics, as some time must elapse after the copper is smelted before it is refined, and the quantity of copper in stocks of untreated or unfinished material at the beginning of the year differs from that at the end, not only at smelters but at the refineries as well.

Two or three months usually elapse between the day ore is mined and the day the copper derived from it becomes available for commercial use. Hence, the refinery statistics for the calendar year 1928 represent approximately the ore mined between October, 1927, and October, 1928. In periods when the course of production is little disturbed by pronounced fluctuations of activity the three sets of statistics should not differ greatly, but any decided fall or rise in production between October of one year and March of the year following tends to accentuate the differences among the three sets of figures.

In these reports the smelter output, including that of furnace-refined Lake copper as well as blister copper, has been adopted as the production of the country because smelter figures permit reasonably accurate determination of the distribution of copper production by States and give also the actual output of copper.

In order to have these figures maintain their value for showing the output of the country, it is necessary to include in them some copper produced directly through the leaching of ores and subsequent precipitation by electrolysis, although this fraction of the production is not actually smelted, as is the cement copper precipitated from solutions by means of scrap iron. Since this electrolytically precipitated copper is very pure, refineries merely resmelt it in order to cast it in commercial forms.

SUMMARY OF DOMESTIC AND WORLD STATISTICS

Summary of statistics of the copper industry in the United States, 1919-1928

	1919	1920	1921	1922	1923
Production of copper:					
Smelter output from domestic ores					
.....pounds.....	1, 286, 419, 329	1, 209, 061, 040	505, 586, 098	950, 285, 947	1, 434, 999, 962
Mine production.....do.....	1, 212, 334, 041	1, 224, 550, 151	466, 190, 853	964, 583, 894	1, 477, 739, 709
Refinery production of new copper—					
Electrolytic.....pounds.....	1, 233, 994, 324	1, 010, 240, 867	506, 532, 984	766, 944, 836	1, 302, 454, 492
Lake.....do.....	177, 594, 135	153, 483, 952	100, 918, 001	122, 545, 126	137, 691, 306
Casting and pig.....do.....	21, 897, 336	18, 698, 421	1, 963, 271	15, 180, 723	24, 019, 197
Total domestic.....do.....	1, 433, 485, 795	1, 182, 423, 240	609, 414, 256	904, 670, 685	1, 464, 164, 995
Total domestic and foreign.....do.....	1, 770, 168, 041	1, 526, 165, 346	950, 777, 815	1, 255, 515, 959	1, 979, 835, 616
Total new and old copper.....do.....	2, 345, 000, 000	2, 151, 000, 000	1, 385, 000, 000	1, 927, 000, 000	2, 802, 000, 000
Ore produced:					
Copper ore.....short tons.....	36, 121, 622	36, 765, 370	13, 396, 382	26, 893, 247	45, 519, 317
Average yield of copper.....per cent.....	1. 65	1. 63	1. 70	1. 74	1. 58
Copper-lead and copper-lead-zinc					
ores.....short tons.....	17, 632	26, 890	14, 248	52, 370	162, 181
Average price per pound.....cents.....	18. 6	18. 4	12. 9	13. 5	14. 7
Imports (unmanufactured).....pounds.....	429, 387, 594	485, 670, 691	350, 472, 611	541, 013, 220	676, 473, 338
Exports of metallic copper ¹ do.....	515, 595, 019	623, 158, 489	628, 415, 714	742, 755, 957	828, 854, 827
Withdrawn from total supply on domestic account:					
Total new copper.....pounds.....	914, 471, 572	1, 053, 838, 558	610, 988, 744	896, 633, 833	1, 300, 473, 331
Total new and old copper.....do.....	1, 489, 000, 000	1, 679, 000, 000	1, 046, 000, 000	1, 568, 000, 000	2, 122, 000, 000
Stocks at end of year:					
Refined copper.....do.....	631, 000, 000	659, 000, 000	459, 000, 000	216, 000, 000	264, 000, 000
Blister and materials in solution.....pounds.....	273, 000, 000	465, 000, 000	283, 000, 000	361, 000, 000	432, 000, 000
Value of smelter production from domestic ores.....	\$239, 274, 000	\$222, 467, 000	\$65, 221, 000	\$128, 289, 000	\$210, 945, 000
World production (smelter).....pounds.....	2, 191, 394, 000	2, 114, 349, 000	1, 229, 277, 000	1, 904, 793, 000	2, 683, 025, 000

¹ See footnote at end of table.

Summary of statistics of the copper industry in the United States, 1919-1928—Con.

	1924	1925	1926	1927	1928
Production of copper:					
Smelter output from domestic ores—pounds.....	1,634,249,192	1,674,869,886	1,739,622,094	1,684,040,983	1,825,900,393
Mine production.....do.....	1,606,165,018	1,678,117,747	1,725,275,931	1,649,959,370	1,809,796,907
Refinery production of new copper—					
Electrolytic.....pounds.....	1,499,223,447	1,533,995,439	1,553,041,424	1,520,076,181	1,607,120,026
Lake.....do.....	145,333,227	138,029,764	172,372,304	195,135,199	179,104,311
Casting.....do.....	29,657,925	10,870,144	5,883,433	3,740,819	5,573,050
Total domestic.....do.....	1,674,214,599	1,682,895,347	1,731,297,161	1,718,952,199	1,791,797,387
Total domestic and foreign—pounds.....	2,260,076,010	2,204,573,824	2,322,485,376	2,325,763,709	2,487,607,779
Total new and old copper.....do.....	3,037,000,000	3,045,000,000	3,282,000,000	3,306,000,000	3,560,000,000
Ore produced:					
Copper ore.....short tons.....	49,178,315	53,103,014	57,181,894	56,725,460	62,097,132
Average yield of copper percent.....	1.59	1.54	1.46	1.41	1.41
Copper-lead and copper-lead-zinc ores.....short tons.....	219,874	228,612	282,015	418,601	351,131
Average price per pound.....cents.....	13.1	14.2	14.0	13.1	14.4
Imports (unmanufactured).....pounds.....	768,813,731	652,971,407	779,441,803	718,322,990	787,073,640
Exports of metallic copper.....do.....	1,116,775,136	1,082,369,439	960,220,112	1,069,493,121	1,121,186,640
Withdrawn from total supply on domestic account:					
Total new copper.....pounds.....	1,354,742,564	1,401,012,091	1,570,136,207	1,422,959,219	1,608,538,878
Total new and old copper.....do.....	2,131,000,000	2,241,000,000	2,530,000,000	2,403,000,000	2,681,000,000
Stocks at end of year:					
Refined copper.....do.....	243,000,000	124,000,000	146,000,000	171,000,000	114,000,000
Blister and materials in solution.....pounds.....	393,000,000	432,000,000	455,000,000	401,000,000	423,000,000
Value of smelter production from domestic ores.....	\$214,087,000	\$237,832,000	\$243,547,000	\$220,609,000	\$262,930,000
World production (smelter).....pounds.....	2,987,263,000	3,093,085,000	3,216,543,000	3,348,821,000	3,756,676,000

¹ Total exports of copper, exclusive of ore, concentrates, and composition metal, and for 1923-1928 of unrefined copper, figures for which are not separable from those for ore and concentrates. For 1926, 1927, and 1928, exclusive also of "Other manufactures of copper," for which figures of quantity are not recorded.

Copper produced in the United States from domestic ores, 1923-1928

[Smelter output, in pounds fine]

State	1923	1924	1925	1926	1927	1928
Alaska.....	68,648,368	77,053,492	72,204,166	67,631,846	56,489,214	40,541,968
Arizona.....	615,493,561	672,365,115	722,653,457	729,324,537	681,168,117	735,632,406
California.....	27,042,835	49,433,716	46,943,604	30,442,961	25,802,603	24,707,992
Colorado.....	4,343,418	4,158,612	3,163,211	4,657,591	8,006,801	10,262,083
Idaho.....	3,664,079	3,148,519	3,144,064	1,171,262	1,811,103	2,336,654
Michigan.....	137,691,306	145,333,227	138,029,764	174,778,884	195,135,199	179,104,311
Missouri.....	217,449	184,947	12,114	54,378	5,041	930
Montana.....	224,353,764	249,322,394	270,604,676	257,271,936	225,208,853	251,046,415
Nevada.....	63,495,928	77,281,479	77,137,503	109,041,769	118,298,342	159,332,977
New Mexico.....	57,521,171	78,145,629	76,467,245	82,848,096	79,761,222	92,777,233
North Carolina.....	61,913	-----	-----	1,468,746	5,362,041	8,207,000
Oregon.....	1,182,437	716,656	126,107	279,223	484,652	375,049
Pennsylvania.....	1,121,573	1,263,535	562,240	495,698	2,149,182	5,013,868
Tennessee.....	18,721,932	18,251,996	19,789,234	18,601,586	14,498,951	16,374,261
Texas.....	4,216	302	785	17,102	25,460	432,968
Utah.....	210,118,291	256,531,349	242,730,986	259,649,158	267,705,597	298,375,465
Vermont.....	-----	-----	-----	446,323	238,143	-----
Washington.....	839,254	978,647	1,184,807	1,336,617	1,706,953	1,197,340
Wyoming.....	87,686	-----	331	-----	-----	2,575
Undistributed.....	390,781	79,577	115,532	104,381	123,509	178,898
	1,434,999,962	1,634,249,192	1,674,869,886	1,739,622,094	1,684,010,983	1,825,900,393

The accompanying table shows the world smelter production of copper by countries where smelted but not necessarily where refined. So far as possible, material from scrap has been eliminated. As the figures for the United States for 1924 to 1926, inclusive, do not include the smelter product from foreign ores, concentrates, and mattes, the content of the imports of these materials has been included in the total for the world, in so far as can be done without duplication of figures shown elsewhere in the table.

World smelter production of copper, 1924-1928, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country ¹	1924	1925	1926	1927	1928
North America:					
Canada.....	24,438	22,180	30,199	31,947	56,619
Mexico.....	33,359	33,531	37,982	39,248	² 39,000
United States.....	³ 741,283	³ 759,708	³ 789,075	⁴ 843,850	⁴ 911,444
	799,080	815,419	857,256	915,045	1,007,063
South America:					
Chile.....	174,496	176,811	188,875	226,160	277,913
Peru.....	⁵ 33,938	⁵ 36,864	⁵ 42,940	46,377	52,292
	208,434	213,675	231,815	272,537	330,205
Europe:					
Austria.....	3,848	3,779	3,203	3,308	3,424
Belgium.....	8,930	11,140	10,006	9,810	² 9,000
Czechoslovakia.....	301	492	718	743	1,010
Finland.....	227	394	365	354	375
France.....	2,299	2,953	1,627	2,250	² 2,000
Germany ⁶	34,600	39,100	46,200	50,600	48,500
Great Britain ⁷	21,500	20,700	17,900	22,600	² 23,000
Italy.....	10	578	420	450	900
Norway.....	71	251	192	13	(⁸)
Rumania ⁹	90	133	189	86	104
Russia ¹⁰	3,147	9,042	10,634	13,597	² 20,000
Spain.....	16,597	21,298	23,925	28,689	27,758
Sweden ¹¹	2,005	3,727	3,894	5,406	² 5,000
Yugoslavia.....	8,101	7,301	9,671	12,863	15,086
	101,726	120,888	128,944	150,769	156,157
Asia:					
China ¹²	842	1,048	2,068	1,052	4,395
Chosen.....		418	766	1,004	607
Japan.....	63,056	66,487	67,365	66,571	66,039
	63,898	67,953	70,199	68,627	71,041
Africa:					
Belgian Congo.....	85,570	90,104	80,639	89,156	112,456
Rhodesia—					
Northern.....	100	75	719	3,343	6,026
Southern.....	2,565	1,714	7		110
Union of South Africa.....	8,383	7,819	8,820	9,324	8,849
	96,618	99,712	90,185	101,823	127,441
Oceania:					
Australia.....	14,326	11,160	11,327	9,718	12,048
Papua ¹³		89	173		
	14,326	11,249	11,500	9,718	12,048
	¹⁴ 1,355,000	¹⁴ 1,403,000	¹⁴ 1,459,000	1,519,000	1,704,000

¹ In addition to the countries listed, copper is smelted in Asiatic Turkey, but data of output are not available.

² Approximate production.

³ Smelter output from domestic material, exclusive of scrap. The production of refined copper from domestic and foreign material, exclusive of scrap, is reported as follows, in metric tons: 1924, 1,025,148 tons; 1925, 999,973 tons; 1926, 1,053,456 tons; 1927, 1,054,943 tons; 1928, 1,128,354 tons.

⁴ Smelter output from domestic and foreign material, exclusive of scrap. The production from domestic material only, exclusive of scrap, was as follows: 1927, 763,864 tons; 1928, 828,210 tons. Figures for smelter output from foreign ores not available prior to 1927.

⁵ Includes copper contained in ores, concentrates, and mattes exported.

⁶ Exclusive of material from scrap. (Metallgesellschaft, Stat. Zusammenstell.)

⁷ Approximate production. (Min. Res. Dept., Imp. Inst.)

⁸ Data not available.

⁹ Smelter output from domestic ores.

¹⁰ Year ended Sept. 30.

¹¹ Exclusive of material from scrap.

¹² Exports of ingots and slabs.

¹³ Copper content of blister exported in year ended June 30 of year stated.

¹⁴ Includes copper content of ores, concentrates, and mattes imported into the United States not elsewhere included.

World mine production of copper, 1924-1928, in metric tons

[Compiled by L. M. Jones, of the Bureau of Mines]

Country ¹	1924	1925	1926	1927	1928
North America:					
Canada.....	47,381	50,553	60,371	63,569	91,941
Cuba ²	10,614	14,135	9,028	13,433	6,431
Mexico.....	50,062	54,596	56,347	59,875	65,506
Newfoundland.....	(³)				(⁴)
United States.....	728,540	761,177	782,568	748,405	820,906
	836,597	880,461	908,314	885,282	984,784
South America:					
Argentina ⁵	800	800	800	800	800
Bolivia ⁶	7,439	7,235	8,130	8,729	8,486
Chile.....	213,856	243,219	243,558	240,446	289,428
Peru.....	33,938	36,844	42,511	55,368	55,301
Venezuela.....	1,778	2,228	2,043	200	
	257,811	290,326	297,042	305,543	354,015
Europe:					
Austria.....	1,941	1,840	2,238	2,332	3,035
Bulgaria ⁵	1,000	1,000	1,700	1,300	1,000
Czechoslovakia.....	(⁷)	(⁷)	600	1,160	1,627
Finland.....	368	1,374	991	836	2,665
France.....	14	145	146	(⁴)	(⁴)
Germany.....	22,944	24,446	27,687	27,271	25,500
Great Britain.....	123	97	110	180	69
Hungary.....	4	5	22	(⁴)	(⁴)
Italy.....	857	826	1,490	1,690	802
Norway.....	9,510	31,693	6,207	12,367	14,000
Portugal ⁸	2,000	2,000	2,000	2,000	2,000
Rumania ⁸	90	133	189	86	104
Russia ⁹	3,312	5,200	11,500	14,400	¹⁰ 15,000
Spain.....	26,291	48,100	49,500	49,600	53,000
Sweden.....	18	213	709	783	800
Yugoslavia.....	8,143	9,693	12,100	12,900	¹¹ 13,000
	76,615	126,765	117,189	126,905	133,000
Asia:					
China ¹⁰	842	1,048	2,068	1,052	4,395
Cyprus.....	2,821	⁶ 3,521	⁶ 3,056	⁶ 4,229	⁶ 4,878
India, British.....	1,254	5,000	5,900	5,100	⁶ 5,000
Japan—					
Japan proper ⁸	63,056	66,487	67,365	66,571	66,039
Chosen ¹¹	(¹¹)	(¹¹)	(¹¹)	(¹¹)	(¹¹)
Taiwan.....	946	689	1,717	1,384	1,300
	68,919	76,745	80,106	78,336	81,612
Africa:					
Algeria.....	560	468	489	273	303
Belgian Congo ⁸	85,570	90,104	80,639	89,156	112,456
French Congo.....	291	300	384	1,121	⁶ 1,000
Madagascar.....		(¹²)			
Morocco, French.....	10	9	⁶ 45	(⁴)	(⁴)
Rhodesia—					
Northern ⁸	100	75	719	3,343	6,026
Southern ⁸	2,565	1,714	7		110
Southwest African Protectorate.....	8,021	8,334	8,984	10,268	11,700
Tunisia.....	15			12	
Union of South Africa ⁸	8,383	7,819	8,820	9,272	8,849
	105,515	108,823	100,087	113,445	140,444
Oceania:					
Australia.....	14,807	12,007	8,862	10,133	9,618
Papua ¹³	2	528	1,686	117	1
	14,809	12,535	10,548	10,250	9,619
	1,360,000	1,496,000	1,513,000	1,520,000	1,703,000

¹In addition to the countries listed, copper is produced in Asiatic Turkey, but data of output are not available.

²Copper content of ore, concentrates, and matte imported into the United States.

³Production of 9 tons of copper ore reported, content not stated.

⁴Data not available.

⁵Approximate production.

⁶Copper content of exports.

⁷The following quantities of copper ore reported produced in Czechoslovakia, content not stated: 1924, 590 tons; 1925, 3,606 tons.

⁸Smelter product.

⁹Year ended Sept. 30.

¹⁰Exports of ingots and slabs.

¹¹The following quantities of copper ore are reported produced in Chosen, content not stated: 1924, 654 tons; 1925, 1,011 tons; 1926, 1,723 tons; 1927, 2,087 tons; 1928, 3,977 tons. In addition, considerable quantities of cupriferous sulphide ores are produced.

¹²Three tons of copper ore exported, content not stated.

¹³Copper content of exports for year ended June 30 of year stated.

GENERAL CONDITIONS

In 1928 the copper industry was characterized not only by an increase of consumption considerably exceeding the recent average yearly rate of increase but a nearly corresponding increase of production so related to the demand for copper that there was a decline of stocks and a steady rise of price. These trends had become intensified at the end of the year, which closed with both production and price at the maximum for the year.

The continent of North America supplies about 60 per cent of the world copper production, and the balance is derived about equally from South America and the rest of the world—a little less than 20 per cent from South America and a little more than 20 per cent from the rest of the world.

Rank of continents in copper production in 1928

Rank	Continent	Per cent of world total
1	North America.....	59.10
2	South America.....	19.38
3	Europe.....	9.16
4	Africa.....	7.48
5	Asia.....	4.17
6	Australia.....	.71
		100.00

About half of the world production of copper is supplied by the United States and about three-fourths by the United States together with Chile and Belgian Congo, next in importance as producers. Japan, Canada, Peru, Germany, and Mexico, each of which produces less than 4 per cent of the total but more than 2 per cent, together contribute about 15 per cent of the world total. The output of the eight countries mentioned amounts to nearly 92 per cent of the world total. Spain, Great Britain, and Russia together provide about 4 per cent of the total. Minor production is made by 15 other countries.

Rank of countries in copper production in 1928

Rank	Country	Per cent of world total
1	United States.....	53.49
2	Chile.....	16.31
3	Belgian Congo.....	6.60
4	Japan.....	3.87
5	Canada.....	3.32
6	Peru.....	3.07
7	Germany.....	2.85
8	Mexico.....	2.29
9	Spain.....	1.63
10	Great Britain.....	1.35
11	Russia.....	1.17
	Other countries.....	4.05
		100.00

In 1928 world production of new copper, as estimated by the Bureau of Mines from official reports, was 1,878,000 short tons. This constitutes an increase of 204,000 tons, or about 12 per cent, over the 1,674,000 tons produced in 1927. Each continent contributed to the increase—the Americas, 165,000 tons; Africa, 28,000 tons; Europe, 6,000 tons; and Asia and Australia together, 5,000 tons. Nearly all of the important copper-producing countries likewise increased their production, notably the United States, with an increase of 74,510 tons; Chile, with 57,048 tons; Canada, with 27,197 tons; and Congo, with 25,683 tons. These four together contributed a total increase of 184,438 tons. Russia, Peru, and Australia increased production 7,012 tons, 6,520 tons, and 2,569 tons, respectively. Only four producers of importance decreased production. The decrease for two of them, Japan and Mexico, amounted to only a few hundred tons; Germany and Spain, however, showed decreases of 2,315 tons and 1,026 tons, respectively.

Although the actual increases by each of the producing countries were generally substantial, a number of the countries—the United States, Mexico, Germany, Great Britain, Spain, and Japan—failed to maintain their relative positions and shares in the world total. The largest decrease in per cent of world's total was that of the United States, represented by a drop from 55.57 per cent in 1927 to 53.50 per cent in 1928, in spite of the fact that production from its domestic ores increased 70,930 tons, or 8.42 per cent, and its production from foreign ores increased 3,580 tons, or 4.06 per cent, making a total increase of 8.01 per cent.

Chile, Canada, and Congo made notable increases in per cent of the world total—1.42, 1.22, and 0.73 per cent, respectively. The tonnage increase in production of each of these countries, although much less than that of the United States, was very large in proportion to its 1927 production. This is highly significant in that it indicates the future trend of production from these three countries. Thus, an actual increase of 27,197 tons from Canada represents an increase of 77 per cent over its 1927 production; an increase of 57,048 tons from Chile represents nearly 23 per cent of its 1927 production; and an increase of 25,683 tons from Congo represents 26 per cent of its 1927 production.

On the whole, the trends of production indicate continued maintenance of the world importance of Western hemisphere production through increased rates of production from Chile, Peru, and Canada whereas the rate of increase from the United States tends to decline slowly. The increasing rate of production from Africa will tend to offset relatively stationary or possibly declining future production from Europe and Asia, and it may be expected to play an important rôle in the latter part of the next decade in providing the increased production required by the future increase in consumption which may be confidently expected.

Production of copper by principal producing countries and changes in relative importance of these sources, 1927 and 1928

	Short tons		Per cent of world total		Increase or decrease		Change in per cent of world total
	1927	1928	1927	1928	Tons	Per cent	
World smelter production.....	1,674,000	1,878,000	100.00	100.00	+204,000	+12.19	-----
North and South America.....	1,309,084	1,474,084	78.21	78.49	+165,000	+12.60	+0.28
North America.....	1,008,663	1,110,096	60.26	59.11	+101,433	+10.06	-1.15
United States.....	930,190	1,004,700	55.57	53.50	+74,510	+8.01	-2.07
From domestic ores.....	842,020	912,950	50.30	48.61	+70,930	+8.42	-1.69
From foreign ores.....	88,170	91,750	5.27	4.89	+3,580	+4.06	-.38
Canada.....	35,215	62,412	2.10	3.32	+27,197	+77.23	+1.22
Mexico.....	43,263	43,000	2.58	2.28	-263	-.61	-.30
South America.....	300,420	363,988	17.95	19.38	+63,568	+21.16	+1.43
Chile.....	249,298	306,346	14.89	16.31	+57,048	+22.88	+1.42
Peru.....	51,122	57,642	3.05	3.07	+6,520	+12.75	+.02
Europe.....	166,194	172,133	9.93	9.17	+5,939	+3.57	-.76
Germany.....	55,777	53,462	3.33	2.85	-2,315	-4.15	-.48
Great Britain.....	24,912	25,000	1.49	1.33	+88	+.35	-.16
Russia.....	14,988	22,000	.90	1.17	+7,012	+46.78	+2.27
Spain.....	31,624	30,598	1.89	1.63	-1,026	-3.24	-.26
Africa.....	112,241	140,479	6.70	7.48	+28,238	+25.16	+2.78
Belgian Congo.....	98,278	123,961	5.87	6.60	+25,683	+26.13	+2.73
Asia.....	75,648	78,309	4.52	4.17	+2,661	+3.52	-.35
Japan.....	73,382	72,795	4.38	3.88	-587	-.80	-.50
Australia.....	10,712	13,281	.64	.71	+2,569	+23.98	+2.07

The world's visible stocks of copper (exclusive of consumers' stocks) decreased nearly 18,000 tons in 1928, following a decrease of nearly 63,000 tons in 1927. World stocks of about 332,000 tons, as of the end of 1928, probably represent nearly a minimum with respect to the prudent conduct of the industry, as about 75 per cent of the total is included in blister copper or copper in process of refining. The balance of about 82,000 tons in refined copper represents less than the average consumption requirements for three weeks.

The average price of copper in the United States during 1928 was 14.4 cents, as determined by total sales reported to the Bureau of Mines, although the price indicated by the average of monthly averages compiled by reputable journals was slightly higher (14.68 and 14.57). This latter average, however, gives undue weight to sales at the higher price range. During the first quarter of the year the price held slightly below 14 cents, but six months later it had risen to 15 cents, and the advance in price continued through the last quarter until it was only slightly less than 16 cents. Some sales were actually made above 16 cents. This rise of price reflected improved demand, resulting from a large increase of consumption, especially in the United States.

From annual estimates of world consumption compiled by the American Bureau of Metal Statistics it may be shown that in recent years slightly more than 49 per cent of world consumption has been taken by North America, slightly more than 43 per cent by Europe, a little less than 5 per cent by Japan, and the balance, less than 3 per cent, by the rest of the world.

World consumption of copper, 1925-1928, in per cent

	1925	1926	1927	1928	Average of averages, 1925-1928
North America.....	49.1	53.1	47.4	49.5	49.8
Europe.....	43.8	39.6	46.1	44.7	43.6
Japan.....	4.9	5.2	4.7	4.4	4.8
	97.8	97.9	98.2	98.6	98.2

In 1928 the apparent increase of consumption was 247,000 short tons, of which 158,000 tons, or 64 per cent of the total increase, was taken by the United States and 84,000 tons, or 34 per cent, was taken by Europe. The consumption of France increased 39 per cent, that of Czechoslovakia 45 per cent, and that of Italy 26 per cent; German consumption decreased 4 per cent.

At the beginning of 1928 United States production was not at full mine and plant capacity, but at the end of the year every effort was being made to increase production.

The rise of price in 1928 has been accompanied by some European complaint, arising chiefly out of the fact that New York has supplanted London as the principal copper market. Probably an important factor in the rise in price has been the increase in consumption of copper as well as all other common metals since the beginning of the twentieth century. The large general increase in the consumption of metals is founded upon the broad development of industrial civilization to which the metals are an absolute necessity. Metal demand amounts to the integration of many thousands of more or less obscure requirements for the maintenance and growth of this new type of civilization.

The demand for copper, itself, is especially supported by a particular use for which it is of preeminent value, namely, in the generation, distribution, and utilization of electricity, which in turn is a continually growing need of modern industry and civilization. Copper is thus so peculiarly favored by circumstances that nothing but the great abundance of its ores, together with the remarkably efficient technology employed in its production, has permitted the low prices that have prevailed. However, there is indubitably a law of diminishing returns applying to further technologic advances in copper production, because the aggregate losses in its treatment have become relatively slight and the maximum benefits of large tonnage production are probably already generally realized in mining, milling, and smelting practice.

Repeatedly in the past a critical stage in the copper industry has been reached at which there was, in fact, some likelihood of a dearth of copper due to more rapid increase in consumption than in production. This has generally been reflected in the price of the metal, although new discoveries of ore deposits and improvements in technology have thus far prevented the development of any very acute situation. For example, it is now recognized that such an acute situation was averted by the technologic developments in mining, milling, and smelting related to the opening of the so-called porphyry coppers. Without the contribution of metal from these low-grade mines the world could

not have had for some years past anything like the tonnage of copper it has actually consumed, even at much higher prices for the metal than those that have prevailed. The apparent immediate possibility of expansion in production of existing mines is not great in comparison with the large tonnage of copper necessary to meet the average percentage expansion in consumption. In 1900 a 10 per cent increase in consumption required only 55,000 tons of production increase; in 1910 a 10 per cent increase required more than 95,000 tons, whereas in 1928 a 10 per cent increase in consumption would have required 167,000 tons, although, as stated, the actual increase for that year was 204,000 tons. It is therefore not unreasonable to find some part, at least, of the cause of a rise in the price of copper in the narrowing margin between accelerated rate of increase in demand and the lesser rate of gain in production.

The present approximate balance between production and demand for copper can not be expected to continue indefinitely. Continued prosperity of industry, resulting in further rapid increase of demand at an early date, would probably press present mine and plant production capacities to their limits; but there are, as previously stated, substantial possibilities for a higher rate of increase in production from South America, Canada, and Africa. In the next few years Chile and Canada are likely to contribute effectively to world requirements for increase in copper production; subsequently Rhodesia as well as Congo should make important contributions. The precise relations between production and consumption that will result can not be forecast, but, on the whole, the available facts indicate that conditions will be at least relatively stable and similar to those of the present. There is some possibility of moderate shortage of production for the next few years and of excess production in the latter part of the next decade, but, broadly speaking, new production now under development may be expected to meet, but not unduly exceed, the requirements of the next few decades.

PRODUCTION

SMELTER PRODUCTION

The copper output of the United States smelters from domestic ores in 1928 was 1,825,900,393 pounds, exceeding the peace-time record output of 1926 by 86,278,299 pounds and representing 49 per cent of the world copper production. The United States percentage of the world total has varied recently as follows:

	Per cent		Per cent		Per cent
1913-----	56	1922-----	50	1926-----	54
1918-----	61	1923-----	53	1927-----	50
1920-----	57	1924-----	55	1928-----	49
1921-----	41	1925-----	54		

Copper produced (smelter output) in the United States, 1845-1928

[Values rounded]

Year	Quantity	Increase	Value	Year	Quantity	Increase	Value
	<i>Pounds</i>	<i>Pounds</i>			<i>Pounds</i>	<i>Pounds</i>	
1845	224,000		\$45,000	1888	226,361,466	45,440,942	\$38,029,000
1846	336,000	112,000	57,000	1889	226,775,962	414,496	30,615,000
1847	672,000	336,000	124,000	1890	259,763,092	32,987,130	40,523,000
1848	1,120,000	448,000	218,000	1891	284,121,764	24,358,672	36,368,000
1849	1,568,000	448,000	349,000	1892	344,998,679	60,876,915	40,020,000
1850	1,456,000	¹ 112,000	320,000	1893	329,354,398	¹ 15,644,281	35,570,000
1851	2,016,000	560,000	334,000	1894	354,188,374	24,833,976	33,648,000
1852	2,464,000	448,000	542,000	1895	380,613,404	26,425,030	40,726,000
1853	4,480,000	2,016,000	985,000	1896	460,061,430	79,448,026	49,687,000
1854	5,040,000	560,000	1,108,000	1897	494,078,274	34,016,844	59,289,000
1855	6,720,000	1,680,000	1,814,000	1898	526,951,987	32,434,713	65,288,000
1856	8,960,000	2,240,000	2,419,000	1899	568,666,921	42,153,934	97,242,000
1857	10,752,000	1,792,000	2,688,000	1900	606,117,166	37,450,245	100,615,000
1858	12,320,000	1,568,000	2,833,000	1901	602,072,519	¹ 4,044,647	100,546,000
1859	14,112,000	1,792,000	3,104,000	1902	659,508,644	57,436,125	80,460,000
1860	16,128,000	2,016,000	3,709,000	1903	698,044,517	38,535,873	95,632,000
1861	16,800,000	672,000	3,696,000	1904	812,537,267	114,492,750	104,005,000
1862	21,160,000	4,360,000	4,655,000	1905	888,784,267	76,247,000	138,650,000
1863	19,040,000	¹ 2,120,000	6,473,000	1906	917,805,682	29,021,415	177,136,000
1864	17,920,000	¹ 1,120,000	8,422,000	1907	868,996,491	¹ 48,809,191	173,799,000
1865	19,040,000	1,120,000	7,473,000	1908	942,570,721	73,574,230	124,419,000
1866	19,936,000	896,000	6,828,000	1909	1,092,951,624	150,380,903	142,084,000
1867	22,400,000	2,464,000	5,682,000	1910	1,080,159,509	¹ 12,792,115	137,180,000
1868	25,984,000	3,584,000	5,976,000	1911	1,097,232,749	17,073,240	137,154,000
1869	28,000,000	2,016,000	6,790,000	1912	1,243,268,720	146,035,971	205,139,000
1870	28,224,000	224,000	5,977,000	1913	1,224,484,098	¹ 18,784,622	189,795,000
1871	29,120,000	896,000	7,023,000	1914	1,150,137,192	¹ 74,346,906	152,968,000
1872	28,000,000	¹ 1,120,000	9,956,000	1915	1,388,009,527	237,872,335	242,902,000
1873	34,720,000	6,720,000	9,721,000	1916	1,927,850,548	539,841,021	474,288,000
1874	23,200,000	4,480,000	8,624,000	1917	1,886,120,721	¹ 41,729,827	514,911,000
1875	40,320,000	1,120,000	9,152,000	1918	1,908,533,595	22,412,874	471,408,000
1876	42,560,000	2,240,000	8,937,000	1919	1,286,419,329	¹ 622,114,266	239,274,000
1877	47,040,000	4,480,000	8,937,000	1920	1,209,061,040	¹ 77,358,289	222,467,000
1878	48,160,000	1,120,000	7,994,000	1921	505,586,098	¹ 703,474,942	65,221,000
1879	51,520,000	3,360,000	9,582,000	1922	950,285,947	444,699,849	128,289,000
1880	60,480,000	8,960,000	12,943,000	1923	1,434,999,962	484,714,015	210,945,000
1881	71,680,000	11,200,000	13,046,000	1924	1,634,249,192	199,249,230	214,087,000
1882	90,646,232	18,966,232	17,313,000	1925	1,674,869,886	40,620,694	237,832,000
1883	115,526,053	24,879,821	19,062,000	1926	1,739,622,094	64,752,208	243,547,000
1884	144,946,653	29,420,600	18,843,000	1927	1,684,040,983	¹ 55,581,111	220,609,000
1885	165,875,483	20,928,830	17,915,000	1928	1,825,900,393	141,859,410	262,930,000
1886	157,763,043	¹ 8,112,440	17,512,000				
1887	181,477,331	23,714,288	25,044,000		41,051,624,027	-----	6,679,522,000

¹ Decrease.

The figures of smelter production in 1928 are based on confidential returns from all known smelting companies handling copper-bearing materials from the United States. Sincere thanks are extended to all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries concerning distribution of the output. The following list gives the names of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1928. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters may be found in the chapters on those metals.

Copper reduction plants that treated materials from the United States in 1928

Location	Company	Final copper product
Arizona:		
Ajo.....	New Cornelia Copper Co.....	Electrolytic.
Clarkdale.....	United Verde Copper Co.....	Blister.
Do.....	United Verde Extension Mining Co.....	Do.
Clifton.....	P Phelps Dodge Corporation.....	Do.
Douglas.....	Calumet & Arizona Mining Co.....	Do.
Do.....	P Phelps Dodge Corporation.....	Do.
Hayden.....	American Smelting & Refining Co.....	Do.
Inspiration.....	Inspiration Cons. Copper Co.....	Electrolytic.
Miami.....	International Smelting Co.....	Blister.
Superior.....	Magma Copper Co.....	Do.
Maryland: Baltimore.....	Baltimore Copper Smelting & Rolling Co.....	Electrolytic.
Michigan:		
Hancock.....	Quincy Mining Co.....	Anodes and Lake.
Houghton.....	Michigan Smelting Co.....	Do.
Hubbell.....	Calumet & Hecla Cons. Copper Co.....	Do.
Montana:		
Anaconda.....	Anaconda Copper Mining Co.....	Blister.
Great Falls.....	do.....	Electrolytic.
Nevada:		
McGill.....	Nevada Consolidated Copper Co.....	Blister.
Thompson.....	Mason Valley Mines Co.....	Do.
New Jersey:		
Chrome.....	United States Metals Refining Co.....	Blister, electrolytic, and casting.
Maurer.....	American Smelting & Refining Co.....	Do.
Perth Amboy.....	Raritan Copper Works.....	Electrolytic.
New York: Laurel Hill.....	Nichols Copper Co.....	Blister and electrolytic.
Tennessee:		
Copperhill.....	Tennessee Copper Co.....	Blister.
Isabella.....	Ducktown Chemical & Iron Co.....	Do.
Texas: El Paso.....	American Smelting & Refining Co.....	Do.
Utah:		
Garfield.....	do.....	Do.
International.....	International Smelting Co.....	Do.
Washington: Tacoma.....	American Smelting & Refining Co.....	Blister and electrolytic.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. As to blister copper, the figures represent the fine copper content. Some casting and electrolytic copper is produced direct from ore or matte, and this is included in the smelter production. Metallic and cement copper recovered by leaching is also included in smelter production.

MINE PRODUCTION

The figures of mine production are based on reports furnished to the Bureau of Mines by all mines producing copper. The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. The figures furnished by mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion are likely to differ considerably from the smelter returns, as the mines may report a considerable quantity that has not reached the stage of blister copper by the end of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters in the following year. This discrepancy is more pronounced if a marked change in rate of production occurs at the beginning or the end of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for

and consequently is not always reported by the mines. The difference between the smelter and the refinery production is accounted for by change in the stocks of blister copper and bluestone and the loss in refining.

Copper produced from domestic ores, as reported by mines, smelters, and refineries, 1919-1928, in pounds

Year	Mine	Smelter	Refinery
1919.....	1, 212, 334, 041	1, 286, 419, 329	1, 433, 485, 795
1920.....	1, 224, 550, 151	* 1, 209, 061, 040	1, 182, 423, 240
1921.....	466, 190, 853	505, 586, 098	609, 414, 256
1922.....	964, 583, 894	950, 285, 947	904, 670, 685
1923.....	1, 477, 739, 709	1, 434, 999, 962	1, 464, 164, 995
1924.....	1, 606, 165, 018	1, 634, 249, 192	1, 674, 214, 599
1925.....	1, 673, 117, 747	1, 674, 869, 886	1, 682, 895, 347
1926.....	1, 725, 275, 931	1, 739, 622, 094	1, 731, 297, 161
1927.....	1, 649, 959, 370	1, 684, 040, 983	1, 718, 952, 199
1928.....	1, 809, 796, 907	1, 825, 900, 393	1, 791, 797, 387

PRODUCTION BY STATES

The mine and smelter production figures, by States, for 1927 and 1928 are shown in the table following; in the second table following the smelter production from 1845 through 1928, by States, is shown. Arizona, Utah, Montana, and Michigan led in production for 1928 with 80 per cent of the smelter output; if the production of Nevada, New Mexico, and Alaska is added to the output of these States, 96 per cent of the output of the country is represented. In total production from 1845 through 1928 Arizona, Montana, and Michigan are especially impressive, having made 31.88, 23.64, and 19.62 per cent, respectively, of the country's total output, and Utah stands fourth with 9.80 per cent; the four States together have produced 85 per cent of the total. If the production of Nevada, New Mexico, Alaska, California, and Tennessee is added to that of the four States mentioned, 98 per cent of the country's total output is represented.

Copper produced in the United States, 1927 and 1928, according to smelter and mine returns, by States, in pounds

State	1927			1928		
	Smelter returns	Mine returns	Rank	Smelter returns		Mine returns
				Per-centage of total	Quantity	
Alaska.....	56, 489, 214	55, 343, 000	7	2. 22	40, 541, 968	41, 421, 000
Arizona.....	681, 168, 117	682, 190, 547	1	40. 29	735, 632, 406	732, 276, 803
California.....	25, 802, 603	27, 133, 008	8	1. 35	24, 707, 992	25, 150, 743
Colorado.....	8, 006, 801	5, 670, 581	10	. 56	10, 262, 083	8, 594, 646
Idaho.....	1, 811, 103	2, 173, 163	13	. 13	2, 336, 654	2, 072, 165
Michigan.....	195, 135, 199	177, 537, 775	4	9. 81	179, 104, 311	178, 442, 704
Missouri.....	5, 041	451, 000	18	-----	930	65, 000
Montana.....	225, 208, 853	223, 492, 639	3	13. 75	251, 046, 415	248, 262, 027
Nevada.....	118, 298, 342	120, 259, 276	5	8. 73	159, 332, 977	158, 876, 883
New Mexico.....	79, 761, 222	74, 251, 863	6	5. 08	92, 777, 233	89, 854, 646
North Carolina.....	5, 362, 041	5, 443, 115	11	. 45	8, 207, 000	8, 207, 000
Oregon.....	484, 652	488, 200	16	. 02	375, 049	358, 463
Pennsylvania.....	2, 149, 182	1, 735, 800	12	. 27	5, 013, 868	4, 977, 885
Tennessee.....	14, 498, 951	14, 940, 595	9	. 90	16, 374, 261	16, 374, 261
Texas.....	25, 460	21, 458	15	. 02	432, 968	447, 792
Utah.....	267, 705, 597	256, 933, 278	2	16. 34	298, 375, 465	293, 235, 039
Vermont.....	238, 143	208, 224	-----	-----	-----	-----
Washington.....	1, 766, 953	1, 685, 848	14	. 07	1, 197, 340	1, 177, 246
Wyoming.....	-----	-----	17	-----	2, 575	2, 604
Undistributed.....	123, 509	-----	-----	. 01	178, 898	-----
	1, 684, 040, 983	1, 649, 959, 370	-----	100. 00	1, 825, 900, 393	1, 809, 796, 907

Copper produced in the United States, 1845-1928, by States

[Smelter output]

State	Pounds	Percent- age	Rank
Alaska.....	1, 117, 727, 217	2. 72	7
Arizona.....	13, 085, 763, 760	31. 88	1
California.....	1, 020, 999, 194	2. 49	8
Colorado.....	328, 832, 818	. 80	10
Idaho.....	133, 231, 240	. 32	11
Michigan.....	8, 053, 995, 921	19. 62	3
Montana.....	9, 704, 543, 923	23. 64	2
Nevada.....	1, 582, 495, 103	3. 86	5
New Mexico.....	1, 212, 851, 320	2. 95	6
Oregon.....	19, 639, 972	. 05	14
Tennessee.....	1 519, 017, 000	1. 26	9
Utah.....	4, 023, 339, 370	9. 80	4
Washington.....	25, 367, 821	. 06	13
Wyoming.....	31, 675, 712	. 08	12
Other States and unapportioned.....	192, 143, 656	. 47	-----
	41, 051, 624, 027	100. 00	-----

¹ Approximate production.*Mine production of copper in the principal districts, 1927 and 1928*

[Districts that produced over 1,000,000 pounds]

District or region	State	1927		1928	
		Mine output (pounds)	Percent- age of total produc- tion	Mine output (pounds)	Percent- age of total produc- tion
Bingham.....	Utah.....	249, 919, 000	15. 15	287, 685, 000	15. 90
Butte.....	Montana.....	221, 312, 000	13. 41	247, 067, 000	13. 65
Lake Superior.....	Michigan.....	177, 538, 000	10. 76	178, 443, 000	9. 86
Yavapai County (mostly Jerome district).	Arizona.....	141, 642, 000	8. 58	165, 297, 000	9. 13
Bisbee (Warren).....	do.....	138, 595, 000	8. 40	161, 492, 000	8. 92
Globe-Miami.....	do.....	171, 167, 000	10. 37	160, 430, 000	8. 86
Ely (Robinson).....	Nevada.....	107, 441, 000	6. 51	141, 969, 000	7. 84
Central (including Santa Rita).....	New Mexico.....	66, 971, 000	4. 06	80, 239, 000	4. 43
Ajo.....	Arizona.....	72, 933, 000	4. 42	1 77, 995, 000	4. 31
Ray (Mineral Creek).....	do.....	62, 860, 000	3. 81	68, 661, 000	3. 79
Morenci-Metcalf.....	do.....	59, 760, 000	3. 62	54, 053, 000	2. 99
Pioneer.....	do.....	28, 221, 000	1. 71	36, 655, 000	2. 03
Plumas County.....	California.....	21, 055, 000	1. 28	21, 141, 000	1. 17
Ducktown.....	Tennessee.....	14, 941, 000	. 91	16, 374, 000	. 90
Yerington.....	Nevada.....	9, 504, 000	. 58	10, 988, 000	. 61
Swain County.....	North Carolina.....	5, 443, 000	. 33	8, 207, 000	. 45
Lebanon (Cornwall mine).....	Pennsylvania.....	1, 736, 000	. 11	4, 978, 000	. 28
Lordsburg.....	New Mexico.....	3, 933, 000	. 24	4, 625, 000	. 26
Bonanza.....	Colorado.....	3, 379, 000	. 20	4, 300, 000	. 24
Battle Mountain.....	Nevada.....	1, 313, 000	. 08	3, 075, 000	. 17
Shasta County.....	California.....	4, 525, 000	. 27	3, 056, 000	. 17
Silver Bell.....	Arizona.....	2, 442, 000	. 15	2, 856, 000	. 16
Park City.....	Utah.....	2, 595, 000	. 16	2, 639, 000	. 15
Tintic.....	do.....	3, 783, 000	. 23	2, 457, 000	. 14
Willow Creek.....	New Mexico.....	1, 989, 000	. 12	2, 120, 000	. 12
Jack Rabbit.....	Nevada.....	1, 392, 000	. 08	2, 026, 000	. 11
Banner.....	Arizona.....	1, 808, 000	. 11	1, 799, 000	. 10
Eureka.....	Colorado.....	1, 534, 000	. 09	1, 487, 000	. 08
Battle Mountain.....	do.....	(²)	-----	1, 219, 000	. 07
Montana.....	Montana.....	1, 575, 000	. 10	(²)	-----
Copper River ³	Alaska.....	(⁴)	(⁴)	(⁴)	(⁴)
Prince William Sound ³	do.....	(⁴)	(⁴)	(⁴)	(⁴)
Index ³	Washington.....	1, 602, 000	. 10	(⁴)	(⁴)

¹ As shown in New Cornelia Copper Co.'s annual report to stockholders.² Less than 1,000,000 pounds.³ Not listed in order of output.⁴ Not at liberty to publish figures.

Copper produced in some of the principal districts to the end of 1928

District or region	State	Date production began	Pounds	Per cent	Rank
Butte.....	Montana.....	1868	9,638,796,000	23.48	1
Lake Superior.....	Michigan.....	1845	8,014,372,000	19.52	2
Bisbee.....	Arizona.....	1880	3,755,912,000	9.15	3
Bingham.....	Utah.....	1896	3,623,262,000	8.83	4
Globe-Miami.....	Arizona.....	1881	2,939,473,000	7.16	5
Jerome.....	do.....	1883	(¹)	(¹)	6
Morenci-Metcalf.....	do.....	1873	1,835,281,000	4.47	7
Ely (Robinson).....	Nevada.....	1908	1,411,534,000	3.44	8
Central (including Santa Rita).....	New Mexico.....	1800	1,067,631,000	2.60	9
Ray (Mineral Creek).....	Arizona.....	1911	1,018,793,000	2.48	10
Shasta County.....	California.....	1897	627,380,000	1.53	11
Ajo.....	Arizona.....	(²)	³ 599,852,000	1.46	12
Ducktown.....	Tennessee.....	1850	519,562,000	1.27	13
Pioneer.....	Arizona.....	(²)	⁴ 220,542,000	.54	14
Plumas County.....	California.....	1865	220,220,000	.54	15
Tintic.....	Utah.....	1880	178,846,000	.44	16
Foothill belt.....	California.....	1862	172,359,000	.42	17

¹ Bureau of Mines not at liberty to publish figures for Jerome district separately for 1924-1928. The total through 1923 was 1,556,324,000 pounds.

² Not recorded.

³ From 1907-1928, inclusive.

⁴ From 1904-1928, inclusive.

QUANTITY AND ESTIMATED RECOVERABLE CONTENT OF COPPER-BEARING ORES

The following tables show the quantity and the estimated recoverable copper content of the ore produced by the mines of the United States in 1925 to 1928. The figures are taken from the mine reports in Mineral Resources. The close agreement between the output as reported by the smelters and the recoverable quantity as reported by the mines indicates that the estimated recoverable tenor is very close to the actual recovery. The classification of some of the complex western ores is difficult and more or less arbitrary. Under copper ores are classed not only those that contain 2.5 per cent or more of copper but those that contain less than this percentage if they are valuable chiefly for copper. Under copper-lead and copper-lead-zinc ores are classed complex ores in which copper is a valuable constituent. Mines report considerable copper from ores mined primarily for other metals. These include siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for their content of other metals.

Copper produced in the United States in 1928 from ores in which copper constitutes the principal value

State	Copper ore (short tons)	Copper produced		Gold produced (fine ounces)	Silver produced (fine ounces)	Value of gold and silver per ton of ore
		Pounds	Percentage			
Alaska.....	579,500	41,421,000	3.57	-----	350,430	\$0.35
Arizona.....	22,583,844	¹ 718,442,138	1.59	161,008.39	² 5,884,088	.30
California.....	900,791	³ 24,751,199	1.37	16,664.75	411,695	.65
Colorado.....	11,983	1,299,636	5.42	769.31	235,581	12.83
Idaho.....	31,454	1,058,944	1.68	559.38	262,938	5.26
Michigan.....	7,361,658	178,442,704	1.21	-----	17,153	4.43
Montana.....	3,147,671	⁵ 236,897,019	3.76	33,231.70	5,657,808	1.27
Nevada.....	6,244,047	156,746,489	1.26	68,530.96	258,519	.25
New Mexico.....	3,733,442	⁶ 87,257,916	1.17	16,481.69	197,389	.12
North Carolina.....	73,330	8,207,000	5.60	89.06	19,040	.18
Oregon.....	4,577	357,041	3.90	248.95	4,104	1.65
Tennessee.....	759,995	16,374,261	1.08	522.93	75,556	.07
Texas.....	4,494	221,713	2.47	-----	2,118	.28
Utah.....	16,631,757	⁷ 276,691,243	.83	115,164.28	1,275,682	.19
Washington.....	28,560	1,165,342	2.04	117.00	22,937	.56
Wyoming.....	29	2,604	4.49	-----	36	.72
Total and average...	62,097,132	1,749,336,249	1.41	413,388.40	14,675,074	.28

¹ Excludes 11,509,594 pounds of copper from mine-water precipitates.

² Excludes 217 ounces of silver from mine-water precipitates.

³ Excludes 206,160 pounds of copper from mine-water precipitates.

⁴ Calculated only on ore that yielded silver.

⁵ Excludes 6,701,580 pounds of copper from mine-water precipitates.

⁶ Includes 387,042 pounds of copper recovered from leaching of a waste dump.

⁷ Excludes 2,229,541 pounds of copper from mine-water precipitates and 3,978,236 pounds of copper from ore leached in place.

Copper produced in the United States, 1925-1927, from ores in which copper constitutes the principal value

State	1925		1926		1927	
	Copper ore (short tons)	Copper produced (pounds)	Copper ore (short tons)	Copper produced (pounds)	Copper ore (short tons)	Copper produced (pounds)
Alaska.....	860,023	73,849,029	670,000	¹ 67,778,000	645,000	55,343,000
Arizona.....	20,628,410	² 709,098,985	22,030,481	³ 718,448,062	⁴ 21,674,826	⁵ 676,549,738
California.....	906,644	44,500,353	831,583	29,698,574	785,366	24,690,901
Colorado.....	2,193	286,410	2,126	315,152	467	54,313
Idaho.....	51,004	2,738,861	28,258	586,387	27,742	1,030,348
Michigan.....	7,036,751	155,157,488	7,641,682	175,381,565	8,046,334	177,537,775
Missouri.....	22	12,100	50	44,000	-----	-----
Montana.....	3,130,087	² 257,629,524	2,825,081	³ 239,039,406	2,929,557	⁶ 212,995,742
Nevada.....	3,923,158	⁷ 78,318,519	4,888,681	³ 100,529,055	4,885,052	⁶ 118,477,899
New Mexico.....	3,172,291	76,101,442	3,644,936	81,242,662	3,124,447	⁷ 71,491,246
North Carolina.....	-----	-----	15,150	1,468,700	38,400	5,443,115
Oregon.....	2,740	105,600	5,632	293,411	16,214	486,480
Tennessee.....	794,930	19,788,234	608,040	18,606,664	630,955	14,940,595
Texas.....	-----	-----	61	9,100	-----	-----
Utah.....	12,575,261	² 216,124,311	13,949,866	³ 239,141,740	13,879,173	⁶ 238,232,386
Vermont.....	-----	-----	14,970	473,200	4,363	208,224
Washington.....	19,500	1,158,812	25,297	1,348,545	37,564	1,684,450
	53,103,014	1,634,869,668	57,181,894	1,674,404,223	56,725,460	1,599,166,212

¹ Includes a small quantity from lead ore.

² Excludes copper from mine-water precipitates, as follows: Arizona, 1,114,770 pounds; Montana, 4,804,364 pounds; Nevada, 476,540 pounds; Utah, 7,359,866 pounds.

³ Excludes copper from mine-water precipitates, as follows: Arizona, 2,350,343 pounds; Montana, 5,044,108 pounds; Nevada, 341,843 pounds; Utah, 1,132,550 pounds.

⁴ Includes 6,695 tons of old tailings.

⁵ Includes copper from 6,695 tons of old tailings.

⁶ Excludes copper from mine-water precipitates, as follows: Arizona, 4,412,437 pounds; Montana, 4,515,407 pounds; Nevada, 189,554 pounds; Utah, 1,221,328 pounds.

⁷ Includes 222,605 pounds of copper recovered from leaching of a waste dump.

⁸ Excludes 5,054,499 pounds of copper from ore leached in place.

⁹ Excludes 4,835,587 pounds of copper from ore leached in place.

Copper ores concentrated, leached, and smelted, and copper produced in the United States by each method in 1928

State	Ore concentrated			
	Short tons	Concentrates produced (short tons)	Copper produced (pounds)	Percentage of copper from ore
Alaska.....	568,362	63,194	28,506,231	2.51
Arizona.....	15,793,494	889,423	382,361,643	1.21
California.....	748,839	42,781	21,140,805	1.41
Idaho.....	30,144	2,475	938,799	1.56
Michigan.....	7,361,658	¹ 141,703	² 178,442,704	1.21
Montana.....	3,064,863	521,972	229,039,043	3.74
Nevada.....	6,081,808	260,989	144,351,889	1.19
New Mexico.....	3,596,144	130,740	79,205,042	1.10
North Carolina.....	12,150	7,900	1,642,000	6.76
Oregon.....	2,800	223	70,300	1.26
Tennessee.....	364,494	34,130	7,461,570	1.02
Utah.....	16,561,500	446,554	271,951,582	.82
Washington.....	28,229	1,748	1,083,683	1.92
Total and average.....	54,214,485	2,643,832	1,346,195,296	1.24

State	Ore leached			Ore smelted		
	Short tons	Copper produced (pounds)	Percentage of copper	Short tons	Copper produced (pounds)	Percentage of copper
Alaska.....				11,138	12,914,769	57.98
Arizona.....	4,116,029	68,897,532	0.84	2,674,321	267,182,958	5.00
California.....				151,952	3,610,394	1.19
Colorado.....				11,983	1,299,636	5.42
Idaho.....				1,310	120,145	4.59
Montana.....				82,808	7,857,976	4.74
Nevada.....	250	7,527	1.51	161,959	12,387,073	3.82
New Mexico.....	(³)	(³)	(³)	137,298	8,052,874	2.93
North Carolina.....				61,180	6,565,000	5.37
Oregon.....				1,777	286,741	8.07
Tennessee.....				395,501	8,912,691	1.13
Texas.....				4,494	221,713	2.47
Utah.....	(⁴)	(⁴)	(⁴)	70,257	4,739,661	3.37
Washington.....				331	81,659	12.34
Wyoming.....				29	2,604	4.49
Total and average.....	4,116,279	68,905,059	.84	3,766,368	334,235,894	4.44

¹ Includes concentrates from sands.

² Includes copper from sands.

³ Continued leaching of a waste dump yielded 387,042 pounds of copper.

⁴ Ore leached in place yielded 3,978,236 pounds of copper; quantity of ore unknown.

Copper ores concentrated and smelted, and copper produced in the United States by each method, 1925-1927

State	Ore concentrated					
	1925		1926		1927	
	Short tons	Copper produced (pounds)	Short tons	Copper produced (pounds)	Short tons	Copper produced (pounds)
Alaska.....	840, 625	45, 785, 584	649, 750	¹ 43, 182, 739	629, 736	37, 959, 263
Arizona.....	16, 723, 155	396, 428, 008	17, 800, 347	410, 065, 457	² 14, 983, 108	³ 355, 901, 387
California.....	785, 280	30, 658, 693	788, 320	26, 768, 333	730, 681	21, 452, 353
Idaho.....	48, 235	2, 416, 822	26, 799	455, 636	26, 562	910, 599
Michigan.....	7, 036, 751	⁴ 155, 157, 488	7, 641, 682	⁴ 175, 381, 565	8, 046, 334	⁴ 177, 537, 775
Montana.....	3, 003, 379	245, 049, 804	2, 684, 887	225, 441, 875	2, 821, 196	203, 034, 611
Nevada.....	3, 844, 631	72, 611, 578	4, 756, 591	93, 428, 616	4, 755, 216	109, 193, 609
New Mexico.....	⁵ 3, 002, 700	⁵ 66, 973, 638	3, 523, 319	74, 035, 200	2, 982, 137	64, 461, 564
Oregon.....	2, 740	105, 600	5, 155	227, 691	16, 018	439, 716
Tennessee.....	342, 066	8, 362, 978	286, 996	10, 796, 413	334, 982	7, 948, 735
Utah.....	12, 538, 300	213, 446, 624	13, 880, 100	233, 465, 293	13, 811, 500	232, 284, 968
Vermont.....	-----	-----	14, 970	473, 200	4, 363	208, 224
Washington.....	18, 907	1, 047, 074	24, 868	1, 220, 990	37, 202	1, 598, 437
	48, 186, 769	1, 238, 043, 891	52, 083, 784	1, 294, 943, 038	49, 179, 035	1, 212, 931, 241

State	Ore smelted					
	1925		1926		1927	
	Short tons	Copper produced (pounds)	Short tons	Copper produced (pounds)	Short tons	Copper produced (pounds)
Alaska.....	19, 398	28, 063, 445	20, 250	24, 595, 261	15, 264	17, 383, 737
Arizona.....	2, 865, 743	295, 380, 453	2, 899, 971	286, 923, 832	2, 552, 903	252, 671, 006
California.....	121, 364	13, 841, 660	43, 263	2, 930, 241	54, 685	3, 238, 548
Colorado.....	2, 193	286, 410	2, 126	315, 152	467	54, 313
Idaho.....	2, 769	322, 039	1, 459	130, 751	1, 180	119, 749
Missouri.....	22	12, 100	50	44, 000	-----	-----
Montana.....	126, 708	12, 579, 720	140, 194	13, 597, 531	108, 361	9, 961, 131
Nevada.....	78, 527	5, 706, 941	132, 090	7, 100, 409	129, 836	9, 284, 290
New Mexico.....	169, 591	9, 127, 804	121, 617	7, 207, 462	142, 310	6, 807, 077
North Carolina.....	-----	-----	15, 150	1, 468, 700	38, 400	5, 443, 115
Oregon.....	-----	-----	477	65, 720	196	46, 764
Tennessee.....	452, 864	11, 425, 256	321, 044	7, 810, 251	295, 973	6, 991, 860
Texas.....	-----	-----	61	9, 100	-----	-----
Utah.....	36, 961	2, 677, 687	69, 766	5, 676, 447	67, 673	5, 947, 418
Washington.....	593	111, 738	429	127, 555	362	86, 013
	3, 876, 733	379, 535, 253	3, 767, 947	358, 002, 412	3, 407, 610	318, 035, 021

¹ Includes a small quantity from lead ore.

² Includes 6,695 tons of old tailings concentrated.

³ Includes copper from 6,695 tons of old tailings concentrated.

⁴ Includes copper from sands.

⁵ A quantity of copper ore from New Mexico was leached, but this may not be shown separately and is included under ore concentrated.

Copper produced from copper-lead and copper-lead-zinc ores in the United States in 1928

State	Copper-lead and copper-lead-zinc ores (short tons)	Copper produced (pounds)	Percentage of copper
Arizona.....	22, 083	291, 798	0. 66
California.....	137	9, 167	3. 35
Colorado.....	366	23, 116	3. 16
Idaho.....	49, 322	177, 369	. 18
Montana.....	192, 839	804, 791	. 21
Nevada.....	40, 329	1, 835, 129	2. 28
Utah.....	45, 355	1, 193, 445	1. 32
Washington.....	700	11, 047	. 79
Total and average.....	351, 131	4, 345, 862	. 62

Copper produced from ores classed as copper-bearing (copper, copper-lead, and copper-lead-zinc ores) and total production of copper from all sources in the United States in 1928

State	From copper, copper-lead, and copper-lead-zinc ores			Copper from all sources, including old slags, smelter cleanings, and precipitates (pounds)
	Ore treated (short tons)	Copper produced (pounds)	Percentage of copper	
Alaska.....	579, 500	41, 421, 000	3. 57	41, 421, 000
Arizona ¹	22, 605, 927	718, 733, 936	1. 59	732, 276, 803
California.....	900, 928	24, 760, 366	1. 37	25, 150, 743
Colorado ²	12, 349	1, 322, 752	5. 36	8, 594, 646
Idaho.....	80, 776	1, 235, 313	. 77	2, 072, 165
Michigan.....	7, 361, 658	178, 442, 704	1. 21	178, 442, 704
Missouri.....				65, 000
Montana ¹	3, 340, 510	237, 701, 810	3. 56	248, 262, 027
Nevada.....	6, 284, 376	158, 581, 618	1. 26	158, 876, 883
New Mexico.....	3, 733, 442	87, 257, 916	1. 17	89, 854, 646
North Carolina.....	73, 330	8, 207, 000	5. 60	8, 207, 000
Oregon.....	4, 577	357, 041	3. 90	358, 463
Pennsylvania.....				4, 977, 885
Tennessee.....	759, 995	16, 374, 261	1. 08	16, 374, 261
Texas.....	4, 494	221, 713	2. 47	447, 792
Utah ¹	16, 677, 112	277, 884, 688	. 83	293, 235, 039
Washington.....	29, 260	1, 176, 389	2. 01	1, 177, 246
Wyoming.....	29	2, 604	4. 49	2, 604
Total and average.....	62, 448, 263	1, 753, 682, 111	1. 40	1, 809, 796, 907

¹ Considerable copper was recovered from mine-water precipitates and from ores not classed as copper ores.

² Most of the copper from Colorado was derived in 1928 from ores classed as siliceous ores and lead-zinc ores.

Copper produced from ores classed as copper-bearing (copper, copper-lead, and copper-lead-zinc ores) and total production of copper from all sources in the United States, 1925-1927

State	1925			1926			1927		
	From copper, copper-lead, and copper-lead-zinc ores		Copper from all sources, including old slags, smelter cleanings, and precipitates	From copper, copper-lead, and copper-lead-zinc ores		Copper from all sources, including old slags, smelter cleanings, and precipitates	From copper, copper-lead, and copper-lead-zinc ores		Copper from all sources, including old slags, smelter cleanings, and precipitates
	Ore treated	Copper produced		Ore treated	Copper produced		Ore treated	Copper produced	
	<i>Short tons</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Short tons</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Short tons</i>	<i>Pounds</i>	<i>Pounds</i>
Alaska.....	880,023	73,849,029	73,855,298	670,000	1,67,778,000	67,778,000	645,000	55,343,000	55,343,000
Arizona ?.....	20,652,975	709,932,148	713,353,129	22,055,501	719,424,088	723,296,051	21,086,756	676,729,022	682,130,547
California.....	906,644	44,500,353	46,864,913	831,966	29,720,699	33,406,269	785,559	24,704,287	27,133,008
Colorado.....	3,610	363,910	2,360,500	2,223	323,277	3,403,850	877	62,597	5,670,581
Idaho.....	57,279	2,829,338	3,297,443	50,295	702,511	1,337,442	67,867	1,294,747	2,173,163
Michigan.....	7,036,751	155,157,488	155,157,488	7,641,682	175,381,565	175,381,565	8,046,334	177,537,775	177,537,775
Missouri.....	22	12,100	12,100	50	44,000	1,077,000			451,000
Montana ?.....	3,325,414	259,012,065	268,910,847	3,049,403	240,689,583	255,372,862	3,193,425	214,588,948	223,492,639
Nevada.....	3,923,283	78,329,945	79,300,224	4,898,832	101,123,855	101,827,937	4,910,356	119,801,203	120,259,276
New Mexico.....	3,172,618	76,142,942	76,427,825	3,644,941	81,242,912	81,642,379	3,127,340	71,641,954	74,251,863
North Carolina.....				15,150	1,468,700	1,468,700	38,400	5,443,115	5,443,115
Oregon.....	2,740	105,600	106,325	5,632	293,411	296,454	16,214	486,480	488,200
Pennsylvania.....			1,025,824			1,018,536			1,735,800
Tennessee.....	794,830	19,788,234	19,788,234	608,040	18,606,664	18,606,664	630,955	14,940,595	14,940,595
Texas.....				61	239,141,740	12,020			21,468
Utah ?.....	12,575,537	216,135,875	236,486,540	13,949,866	299,141,740	257,464,482	13,953,051	240,451,102	256,938,278
Vermont.....				14,970	473,200	4,363			208,224
Washington.....	19,500	1,159,812	1,159,057	25,297	1,348,545	1,351,890	37,564	1,684,450	1,685,848
	53,331,626	1,637,317,839	1,678,117,747	57,463,909	1,677,771,850	1,725,275,931	57,144,061	1,604,897,499	1,649,959,370

¹ Includes a small quantity of copper from lead ore.

² Considerable copper was recovered from mine-water precipitates and from ores not classed as copper ores.

Copper ores produced in the United States, 1919-1928, and average yield in copper, gold, and silver

Year	Smelting ores		Concentrating ores		Total				
	Short tons	Yield in copper (per cent)	Short tons	Yield in copper (per cent)	Short tons	Yield in copper (per cent)	Yield per ton in gold (ounce)	Yield per ton in silver (ounce)	Value per ton in gold and silver
1919	3,465,880	4.64	30,769,966	1.35	36,121,622	1.65	0.0052	0.356	\$0.51
1920	3,200,509	4.89	31,348,340	1.34	36,765,370	1.63	.0047	.331	.46
1921	1,235,602	4.77	11,022,544	1.44	13,396,382	1.70	.0039	.357	.44
1922	2,278,047	5.36	23,258,970	1.43	26,893,247	1.74	.0049	.386	.49
1923	3,496,728	5.12	40,209,754	1.29	45,519,317	1.58	.0060	.321	.39
1924	3,554,915	5.08	44,427,264	1.33	49,178,315	1.59	.0063	.325	.35
1925	3,876,733	4.90	48,186,769	1.28	53,103,014	1.54	.0065	.338	.37
1926	3,767,947	4.75	52,083,784	1.24	57,181,894	1.46	.0064	.293	.31
1927	3,407,610	4.67	49,179,035	1.23	56,725,460	1.41	.0065	.255	.28
1928	3,766,368	4.44	54,214,485	1.24	62,097,132	1.41	.0067	.236	.28

REVIEW BY STATES AND COMPANIES

SCOPE OF DISCUSSION

This section summarizes the conditions affecting production in the principal copper districts of the country. The tenor of the ore from each district is given, so far as it does not disclose the production of those individual companies whose figures of output have not already been published in their annual reports or elsewhere. More detailed information on the mining operations of the districts is given in the chapters on mine production.

In this report the individual companies' figures for metal output, ore reserves, metal content, and recovery in treatment, unless otherwise stated, are quoted from the published official reports of the companies. The chapter on copper in Mineral Resources for 1915 contains a map showing the location of the copper-producing districts and the metallurgical plants and also a brief discussion of the geologic occurrence of the ores in the several districts.

In 1928 the American Smelting & Refining Co. had available for dividends, after deducting all charges, taxes, bond interest, depreciation, and depletion, a net income of \$18,586,204, compared with \$15,477,770 in 1927. During the year the company expended, without additional financing, \$14,971,900 for new undertakings and betterments and \$9,943,750 for retirement of bonds. It continued to acquire interests in companies manufacturing brass and copper. These have been vested in a new company, the Republic Brass Corporation, in which the American Smelting & Refining Co. has a substantial interest. Statistics on the company's operations for several years are given in the following table:

Operations of the American Smelting & Refining Co., 1924-1928

	1924	1925	1926	1927	1928
PRODUCTION					
Gold.....ounces.....	1,868,407	1,667,849	1,634,158	1,479,899	1,407,286
Silver.....do.....	92,229,349	82,223,189	85,482,438	80,671,759	81,434,214
Platinum and palladium.....do.....	1,998	(1)	(1)	(1)	(1)
Lead.....short tons.....	412,416	455,261	469,607	476,988	471,880
Copper.....do.....	522,472	502,831	525,897	536,830	563,713
Zinc.....do.....	39,450	45,246	48,723	52,170	47,433
Tin.....do.....	486	(1)	(1)	(1)	(1)
Sulphuric acid.....do.....	35,259	(1)	(1)	(1)	(1)
Arsenic.....do.....	10,473	(1)	(1)	(1)	(1)
By-product metals.....pounds.....	20,146,769	(1)	(1)	(1)	(1)
OPERATING STATISTICS					
Number of men employed.....	25,765	26,401	28,612	27,363	26,757
Charge smelted.....short tons.....	5,160,236	5,638,730	5,433,547	4,643,306	4,330,508
Bullion refined.....do.....	898,390	936,346	990,295	1,004,196	1,038,030
Coal used.....do.....	447,710	390,981	413,351	413,366	416,351
Coke used.....do.....	486,459	517,401	508,033	492,171	386,478
Fuel oil used.....barrels.....	2,046,663	2,268,267	1,836,923	1,627,258	1,706,651
Gas used.....cubic feet.....	4,257,998,000	5,432,356,000	6,223,869,000	6,402,907,000	5,158,775,000
Ore mined.....short tons.....	1,551,259	1,656,212	1,875,991	2,234,880	2,482,998
Coal mined.....do.....	501,779	433,440	749,646	810,329	738,483
Coke produced.....do.....	206,189	323,384	360,270	366,909	340,893

¹ Not given.

ALASKA

The output of blister copper from Alaska ores was 40,541,968 pounds in 1928, a decrease from 56,489,214 pounds in 1927. The 1928 production raised Alaska's total recorded production to 1,117,727,217 pounds, 2.72 per cent of the country's total from 1845 to 1928. Alaska remained in seventh place in 1928 among the copper-producing States. In smelter production for 1928 Alaska continued to rank seventh also, with 2.22 per cent of the total production of the country.

Prince William Sound.—The Beatson mine of the Kennecott Copper Corporation produced 442,765 tons of ore, having an average copper content of 1.26 per cent and 0.264 ounce of silver per ton. The mill treated the entire tonnage, yielding 30,216 tons of concentrates, with a copper content of 15.38 per cent—a recovery of 83.28 per cent. In 1927 the production amounted to 448,200 tons of ore, averaging 1.57 per cent of copper; it yielded 36,422 tons of concentrates, averaging 16.50 per cent of copper—a recovery of 85.36 per cent.

Copper River district.—At Kennecott 74,688 tons of ore was produced, containing an average of 12.50 per cent of copper and 2.44 ounces of silver per ton. Of this quantity 69,738 tons was treated at the mill at Kennecott and yielded 16,362 tons of concentrates, with an average content of 39.29 per cent of copper—a recovery of 94.42 per cent. In 1927, 90,393 tons of ore, containing an average of 12.44 per cent of copper, was mined at Kennecott.

At the property of the Mother Lode Coalition Mines Co., 61,074 tons of ore was produced, containing an average of 11.72 per cent of copper and 1.63 ounces of silver per ton. Shipments to the smelter totaled 15,047 tons containing 13,417,520 pounds of copper and 93,008 ounces of silver.

ARIZONA

Arizona is the most important copper-producing State, both in production for 1928 and in total production for the country from 1845 through 1928. In 1928 Arizona produced 735,632,406 pounds

of copper, 40.29 per cent of the total for the United States; Montana, the nearest competitor in total production through 1928, produced 13.75 per cent of the country's total in 1928. Arizona's total production through 1928 is 13,085,763,760 pounds, 31.88 per cent of the total United States production; Montana has produced 23.64 per cent of the United States total and Michigan 19.62 per cent. Arizona came into the lead in total production in 1920. In 1919 Montana stood first, with 27.59 per cent of the total production, and Arizona was a close second, with 27.45 per cent. Among the six most important States in the output of copper, Arizona is the only one whose production is not made almost entirely from one district.

Bisbee district.—The Bisbee district produced more copper during the period from 1845 through 1928 than any other district in Arizona, but from 1916 through 1927 the Globe-Miami district had a considerably larger annual production. In 1928 the Jerome district ranked first in Arizona, Bisbee second, and Globe-Miami third. Among the country's copper-producing districts leading in total production, Bisbee, with a total recorded production through 1928 of 3,755,912,000 pounds of copper, ranks next to the Butte and Lake Superior districts. Bisbee ranked fifth in production for 1928, with 161,492,000 pounds of copper.

Copper produced in Bisbee district, Arizona, 1919–1928, in pounds

1919-----	122, 311, 000	1924-----	140, 630, 000
1920-----	118, 448, 000	1925-----	145, 433, 000
1921-----	37, 249, 000	1926-----	140, 668, 000
1922-----	79, 591, 000	1927-----	138, 595, 000
1923-----	123, 884, 000	1928-----	161, 492, 000

The Phelps Dodge Corporation, its branches and subsidiaries, produced ores in 1928 that yielded the following metals: Copper, 204,273,993 pounds; lead, 4,358,321 pounds; silver, 1,370,494 ounces; gold, 41,301 ounces; and manganese, 3,049,450 pounds. Its purchased ores yielded 3,676,247 pounds of copper, 10,330,241 pounds of lead, 3,292,666 ounces of silver, and 17,188 ounces of gold.

At the Copper Queen branch copper production from the limestone mines declined considerably from the 1927 figures. Development work amounted to 33,830 feet, as compared with 27,104 feet in 1927. The Southwest Division practically became exhausted; production from the Czar and Holbrook mines will replace that of the Southwest, but the grade of the ore will probably be lower in the future. Caving operations in the Southeast Extension produced a greater tonnage of ore than in 1927 and yielded 12,414,089 pounds of copper, as compared with more than 10,000,000 pounds of copper obtained from 250,000 tons of ore in 1927. Sacramento Hill produced 1,363,892 tons of ore, of which 981,818 tons was milling ore, 151,088 tons smelting ore, and 230,986 tons leaching ore. The milling and smelting ore yielded 60,165,631 pounds of copper, 177,269 ounces of silver, and 7,741 ounces of gold. These figures indicate a general increase in metals obtained but a decrease in output of ore. The copper department of the concentrator milled 1,263,729 dry tons of ore, with an average grade of 2.10 per cent of copper, a slight gain in tonnage and an increase of 0.45 point in average grade. Because of the higher grade of the ore treated during 1928, it was necessary to drop the ratio of concentration from 9.21 into 1 that

prevailed in 1927 to 7.93 into 1 in 1928. The recovery of total copper was 91.26 per cent, compared with 87.53 per cent in 1927. The Don Luis precipitation plant was enlarged early in the year, and after April production was increased materially. Total shipments to the smelter contained over 10,500,000 pounds of copper; leaching operations still continued good and the apparent recovery from the precipitation plant was 97.11 per cent. A small plant near the Holbrook Shaft was put in operation for treatment of the acid Czar mine water and enriched liquors from underground leaching in the Holbrook division. The reduction plant at Douglas produced 153,396,074 pounds of copper, 1,759,576 ounces of silver, and 38,652 ounces of gold from 816,926 tons of material smelted.

Metals produced by Copper Queen branch of Phelps Dodge Corporation, 1919-1928

Year	Ore	Copper	Silver	Gold	Lead	Zinc
	<i>Short tons</i>	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	606,386	68,614,002	492,326	10,813	9,372	-----
1920.....	832,172	71,443,396	486,698	8,846	243,836	-----
1921.....	515,652	30,610,173	495,179	4,650	4,916,418	-----
1922.....	389,367	47,962,123	1,132,304	11,972	8,560,525	247,793
1923.....	1,189,570	87,935,334	933,729	19,151	6,307,412	610,709
1924.....	2,022,196	109,117,018	906,521	29,850	6,094,613	-----
1925.....	1,940,737	116,379,978	1,079,733	32,007	7,103,853	-----
1926.....	1,921,021	109,269,035	907,292	35,382	3,868,259	-----
1927.....	1,838,665	106,351,930	781,989	32,651	4,031,433	-----
1928.....	1,785,739	115,570,399	684,006	32,711	4,277,156	-----

Metals produced by Copper Queen branch of Phelps Dodge Corporation in 1928

	Ore, dry weight	Gold	Silver	Copper	Lead	Manganese
Underground limestone:						
Copper—	<i>Short tons</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Limestone.....	273,053	9,717	264,313	25,258,401	-----	-----
Lease.....	67,533	12,962	139,637	5,981,782	-----	-----
	340,586	22,679	403,950	31,240,183	-----	-----
Lead—						
Smelting.....	15,139	922	54,435	110,287	3,504,779	-----
Milling.....	3,043	153	11,284	5,475	555,565	-----
Lease.....	1,398	80	7,408	68,500	216,812	-----
	19,580	1,155	73,127	184,262	4,277,156	-----
Manganese:						
Lease.....	3,752	-----	-----	-----	-----	3,049,450
	3,752	-----	-----	-----	-----	3,049,450
Underground porphyry:						
Milling.....	280,536	1,136	29,431	12,414,089	-----	-----
	280,536	1,136	29,431	12,414,089	-----	-----
Sacramento Hill:						
Smelting.....	151,088	1,516	53,413	19,556,970	-----	-----
Milling.....	981,813	6,225	123,856	40,608,661	-----	-----
	1,132,906	7,741	177,269	60,165,631	-----	-----
Precipitates:						
Sacramento Hill.....	7,600	-----	187	10,467,726	-----	-----
Holbrook.....	717	-----	42	1,007,756	-----	-----
Underground leaching.....	62	-----	-----	90,752	-----	-----
	8,379	-----	229	11,566,234	-----	-----
	1,785,739	32,711	684,006	115,570,399	4,277,156	3,049,450

The smelter of the Calumet & Arizona Mining Co. produced from ores and concentrates from all sources 122,319,580 pounds of blister copper in 1928, compared with 111,865,800 pounds in 1927. The sulphuric acid plant was operated throughout the year, producing more than 66,000 tons of 60° Baumé acid. The company did 63,003 feet of development work, as compared to 57,224 feet in 1927. Ore reserves were increased decidedly. The Campbell ore body has been extended from the 1,400 level to the 2,200 level, and many new bodies of ore have been discovered in the Junction area. The mines at Bisbee produced 511,095 wet tons of ore averaging 5 per cent of copper, as compared with 4.95 per cent during 1927.

Metals produced by Calumet & Arizona Mining Co., 1919-1928

Year	Refined copper produced (domestic)	Gold	Silver	Dividends
	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>	
1919.....	44,991,107	28,530	995,366	\$1,927,563
1920.....	42,430,847	32,520	932,489	2,570,084
1921.....	17,855,613	12,365	419,647	1,285,043
1922.....	30,830,615	23,349	642,174	1,285,047
1923.....	42,166,930	35,693	824,768	2,248,849
1924.....	41,582,030	31,934	813,791	1,285,063
1925.....	44,557,219	37,287	832,434	2,571,028
1926.....	45,533,208	35,554	972,650	3,856,542
1927.....	48,164,083	33,556	1,015,450	3,856,542
1928.....	51,732,822	37,605	1,248,700	4,499,299

The following figures cover the operations of the Shattuck Denn Mining Corporation during 1928:

Metallic production of the Shattuck Denn Mining Corporation in 1928

Shattuck mine:

Copper ore mined.....	wet short tons..	29,893.94
Copper ore treated.....	dry short tons..	26,917.73
Average moisture in copper ore.....	per cent.....	6.28
Lead ores mined—		
Shipping ore.....	wet short tons..	3,872.25
Milling ore.....	do.....	9,740.83
Lead ores treated—		
Shipping ore.....	dry short tons..	3,615.36
Milling ore.....	do.....	10,548.54
Copper recovered from copper ores.....	pounds.....	2,938,891
Gold from copper ores.....	ounces.....	344.27
Silver from copper ores.....	do.....	25,951
Lead recovered—		
From ore smelted.....	pounds.....	544,086
From ore milled.....	do.....	1,004,277
Gold from lead ores smelted or milled.....	ounces.....	820.74
Silver from lead ores smelted or milled.....	do.....	54,612

Denn mine:

Copper ore mined.....	wet short tons..	18,785.55
Copper ore treated.....	dry short tons..	17,487.04
Average moisture in copper ore.....	per cent.....	7.09
Copper recovered.....	pounds.....	1,997,940
Gold from copper ores.....	ounces.....	466.06
Silver from copper ores.....	do.....	29,190
Net operating cost per pound of copper.....	cents.....	15.843
Average price per pound received for copper.....	do.....	14.897

Metals produced by Shattuck Denn Mining Corporation, 1919-1928

[Shattuck Arizona Copper Co. prior to 1925]

Year	Copper (from cop- per ores)	Silver (from cop- per ores)	Gold (from cop- per ores)	Lead re- covered	Copper recovered
	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Pounds</i>	<i>Per cent</i>
1919.....	2, 111, 841	89, 724	300	4, 432, 655	4. 74
1920.....	2, 374, 148	73, 718	575	8, 254, 603	6. 19
1921 ¹	287, 928	12, 093	29	-----	7. 94
1922.....	-----	-----	-----	-----	-----
1923.....	3, 223, 209	157, 124	1, 349	1, 590, 682	6. 42
1924.....	2, 630, 185	72, 671	754	5, 244, 526	6. 44
1925.....	1, 828, 099	34, 246	633	3, 757, 811	5. 52
1926.....	3, 045, 518	46, 905	960	5, 798, 362	6. 56
1927.....	4, 145, 711	36, 359	719	5, 011, 837	6. 88
1928.....	4, 936, 831	55, 141	810	1, 548, 363	5. 56

¹ Result of development work only. No productive operations carried on.

Globe-Miami district.—From 1916 through 1927 the Globe-Miami district was the most important copper-producing district in Arizona; in production for 1928 it followed the Jerome and Bisbee districts in rank. The Globe-Miami district ranks second in Arizona to the Bisbee district in total production for the period from 1845 through 1928, with a total recorded output of 2,939,473,000 pounds. In total output the Globe-Miami district ranks fifth among the copper-producing districts of the country, and in output for 1928 it ranks sixth. The district produced 160,430,000 pounds of copper in 1928, as compared with 171,167,000 pounds in 1927.

Copper produced in Globe-Miami district, Arizona, 1919-1928, in pounds

1919.....	171, 106, 000	1924.....	190, 452, 000
1920.....	176, 215, 000	1925.....	175, 272, 000
1921.....	76, 488, 000	1926.....	175, 386, 000
1922.....	170, 035, 000	1927.....	171, 167, 000
1923.....	198, 426, 000	1928.....	160, 430, 000

The Old Dominion Co. mined 353,392 tons in 1928 and 356,697 tons in 1927; the grade was 2.92 per cent copper in 1928 and 3.42 per cent in 1927. The refined copper produced was 17,717,267 pounds, as compared with 21,570,615 pounds in 1927. The following results were obtained at the concentrator.

	1926	1927	1928
Copper assay of heads.....per cent.....	4. 01	3. 49	2. 97
Copper assay of concentrates.....do.....	19. 45	21. 10	21. 48
Copper assay of tails.....do.....	. 31	. 27	. 27
Ratio of concentration.....	5.23 to 1	6.52 to 1	8.04 to 1

*Metals produced by Old Dominion Co., 1919-1928*¹

Year	Ore	Refined copper	Gold	Silver	Average grade of ore in copper
	<i>Short tons</i>	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Per cent</i>
1919.....	253,686	28,166,396	5,756	137,071	4.28
1920.....	249,111	22,854,452	3,484	181,010	4.79
1921.....	61,753	7,389,648	1,187	71,155	5.31
1922.....	202,954	18,573,239	3,317	122,095	5.14
1923.....	289,695	26,764,801	5,137	190,033	4.95
1924.....	294,999	25,400,670	5,531	155,814	4.62
1925.....	355,623	27,283,655	5,752	150,752	4.16
1926.....	362,213	25,425,833	7,040	149,235	3.94
1927.....	356,697	21,570,615	(²)	(²)	3.42
1928.....	353,392	17,717,267	(²)	(²)	2.92

¹ Includes custom metals produced.² Not given.

The Miami Copper Co.'s mill treated 4,260,599 tons of ore (an average of 11,835 tons per day), compared with 4,116,255 tons in 1927. The ore averaged 0.853 per cent in 1928 and 0.855 per cent in 1927. The concentrates obtained in 1928 averaged 38.36 per cent of copper, compared with an average of 34.26 per cent in 1927. The ratio of concentration in 1928 was 65.7 to 1. Underground development work amounted to 84,619 feet, as compared with 72,726 feet in 1927. From the concentrates 48,259,448 pounds of refined copper was obtained in 1928, as compared with 53,038,218 pounds in 1927. The cost of producing copper during the year was 11.9075 cents per pound, while the average sales price was 14.9997 cents. On January 1, 1929, the ore reserves were as follows:

Ore reserves of Miami Copper Co., January 1, 1929

	Short tons	Per cent copper	
		Total	Soluble
Sulphide ore.....	95,397,981	0.88	1.09
Mixed ore.....	7,000,000	1.83	1.34
	102,397,981	-----	-----

Copper produced by Miami Copper Co., 1919-1928

Year	Ore	Copper content	Mill extraction	Refined copper	Dividends
	<i>Short tons</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Pounds</i>	
1919.....	1,698,446	2.040	82.38	54,221,638	\$1,867,785
1920.....	1,801,958	1.968	82.48	55,581,328	1,494,228
1921.....	1,868,757	1.758	85.37	53,311,941	1,494,228
1922.....	2,183,020	1.883	86.36	67,454,447	1,494,228
1923.....	2,380,155	1.697	83.98	64,448,345	1,494,228
1924.....	2,444,079	1.624	80.17	60,475,547	1,494,228
1925.....	2,919,600	1.287	72.60	51,851,274	933,893
1926.....	3,793,207	.979	76.77	55,289,174	840,505
1927.....	4,116,255	.855	77.64	53,038,218	1,120,674
1928.....	4,260,599	.853	68.41	48,259,448	1,120,674

Milling operations of Miami Copper Co. in 1928

Ore milled.....	short tons..	4, 260, 599
Copper in ore.....	per cent..	0. 853
Concentrates produced.....	short tons..	64, 853
Copper in concentrates.....	{per cent..	38. 358
	{pounds..	49, 752, 014
Copper recovered per ton of ore.....	do.....	11. 68
Mill extraction.....	per cent..	68. 41

Cost of copper in concentrates f. o. b. cars at Miami, Ariz., in 1928

	Per ton of ore	Per pound of copper
Mining.....	\$0. 40667	\$0. 03590
Milling.....	. 38176	. 03370
General.....	. 16545	. 01461
	. 95388	. 08421

During 1928 the Inspiration Consolidated Copper Co. mined 4,879,646 tons of ore, as follows:

Ore mined by the Inspiration Consolidated Copper Co. in 1928

	Short tons	Per cent copper
Concentrating and smelting ores.....	1, 838, 164	1. 296
Leaching ores.....	3, 041, 482	1. 022
	4, 879, 646	1. 125

The derivation of this ore and the amount of copper produced may be tabulated as follows:

Copper produced by the Inspiration Consolidated Copper Co. in 1928

	Ore treated (tons)	Copper produced (pounds)
Inspiration concentrating ore.....	221, 158	3, 897, 176
Live Oak concentrating ore.....	1, 410, 456	31, 078, 408
Keystone concentrating ore.....	200, 676	3, 337, 936
Inspiration ore to smelter.....	3, 442	66, 653
Live Oak ore to smelter.....	2, 432	50, 414
Inspiration leaching ore.....	231, 335	4, 812, 907
Live Oak leaching ore.....	907, 494	14, 231, 627
Keystone leaching ore.....	1, 903, 143	30, 648, 190
	4, 880, 136	88, 123, 311
Plus net production from soluble anode inventory.....		380, 789
Net production available for sales.....		88, 504, 100

During the year 1,832,290 tons of ore averaging 1.296 per cent of copper was milled, producing concentrates that averaged 36.411 per cent of copper. The flotation concentrates averaged 38.86 per cent and the recovery of copper was 83.14 per cent, while the recovery of sulphide copper in the ore averaged 94.87 per cent. The sulphide ore produced was mined at the rate of 10.895 tons per man-shift, while the ore shipped to the leaching plant was mined at the rate of

13.557 tons per man-shift. In addition to 9,219 feet of diamond drilling and 562 feet of churn drilling, 117,182 feet of development work was carried on underground. During the year a total of 3,040,171 tons of ore was charged into the leaching tanks, an average of 8,636.8 tons (dry) per tank. The average extraction of total copper amounted to 80.373 per cent.

Mill statistics, Inspiration Consolidated Copper Co., in 1928

Total ore milled	dry tons	1, 832, 290
Ore milled per day	do	5, 176
Average number of sections running		5. 298
Average rate per section	tons	977
Screen analysis of feed (on 48 mesh)	per cent	1. 8
Assay mill feed	per cent of copper	1. 296
Copper in feed, oxidized	per cent	. 236
Copper assay of general tailings	do	. 241
Copper in general tailings, oxidized	do	. 185
Copper in general concentrates, smelter assay	do	36. 411
Copper in flotation concentrates	do	38. 86
Copper in table concentrates	do	4. 25
Moisture in general concentrates	do	9. 84
Ratio of concentration		33. 782
Recovery of copper	per cent	83. 14
Recovery of copper sulphides	do	94. 87
Water used per ton of ore	tons	1. 298
Power used per ton of ore milled:		
Coarse crushing	kilowatt-hours	. 47
Fine grinding and concentrating	do	8. 96
Blowers for flotation air	do	2. 06
Filtering and reclaiming water	do	. 76
Lighting	do	. 21
		12. 46
Steel balls consumed in fine grinding per ton of ore milled	pounds	1. 2564
Flotation material used per ton of ore milled:		
Lime	do	1. 1073
Sodium and potassium xanthate	do	. 0666
Pine oil	do	. 1309
Sodium aerofloat	do	. 0003
		1. 3051

The Iron Cap Copper Co. did not operate its Globe mines during 1928. The Iron Cap Copper Co. controls 75 per cent of the stock in the Christmas Copper Co.'s property and was constructing a concentrator during 1928 on this property. The new plant is designed to handle 400 tons daily. The property at Christmas, Ariz., produced 37,686 tons of ore yielding 1,459,707 pounds of copper.

Metallic production of the Iron Cap Copper Co., 1923-1928 ¹

	1923	1924	1925	1926	1927
Ore (dry weight) short tons	83, 931	83, 312	55, 035	67, 215	17, 931
Silver recovered ounces	75, 952	85, 680	149, 513	103, 601	66, 358
Copper recovered pounds	6, 134, 162	5, 383, 059	4, 566, 501	3, 897, 780	1, 580, 189
Average price received:					
Per ounce of silver	\$0. 77826	\$0. 6725	\$0. 689	\$0. 628	\$0. 562
Per pound of copper	\$0. 14446	\$0. 13024	\$0. 13949	\$0. 13808	\$0. 12356

¹ No production in 1928.

The Arizona Commercial Mining Co. produced 60,948 tons of ore averaging 4.48 per cent of copper, as compared with 66,517 tons averaging 4.70 per cent in 1927. From this ore 4,665,605 pounds of copper, 29,074 ounces of silver, and 793 ounces of gold were obtained in 1928. The company did 3,114 feet of development work, as compared with 3,531 feet in 1927. Development work during recent years has disclosed little new ore.

Copper, gold, and silver produced by the Arizona Commercial Mining Co., 1919-1928

Year	Refined copper	Gold	Silver	Year	Refined copper	Gold	Silver
	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>		<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>
1919.....	7,280,861	1,310	16,918	1924.....	7,760,931	1,883	32,634
1920.....	7,913,836	1,722	31,028	1925.....	7,860,866	1,972	39,430
1921.....	572,616	163	3,001	1926.....	5,985,607	1,444	34,614
1922.....	6,220,923	1,585	27,532	1927.....	5,505,448	1,157	32,664
1923.....	8,115,212	2,143	37,826	1928.....	4,665,605	793	29,074

Morenci-Metcalf district.—The copper production of the Morenci-Metcalf district amounted to 54,053,000 pounds, as compared with 59,760,000 pounds in 1927. In total output through 1928 the district ranks seventh among the copper-producing districts of the United States.

Copper produced in Morenci-Metcalf district, Arizona, 1919-1928, in pounds

1919.....	44,868,000	1924.....	41,047,000
1920.....	35,746,000	1925.....	59,464,000
1921.....	11,420,000	1926.....	63,950,000
1922.....	14,175,900	1927.....	59,760,000
1923.....	28,735,000	1928.....	54,053,000

The Morenci branch of the Phelps Dodge Corporation mined 1,550,804 tons of ore, of which 1,550,720 tons was concentrating ore and 84 tons was furnace ore. The total development work, including drifts, winzes, raises, and tunnel and stope developments, amounted to 34,147 feet. The concentrator treated 1,563,706 tons of ore and produced 107,226 dry tons of concentrates. The average grade of the ore was lower and the ore was more refractory than in 1927, resulting in a decreased recovery. The changes made during the year will increase the capacity of the mill from 4,300 tons to 5,000 tons. The Clifton smelter operated satisfactorily during the year, treating 131,430 tons of new metal-bearing material and producing 54,089,000 pounds of copper bullion.

Yavapai County.—The output of copper in Yavapai County, mostly from the Jerome district, in 1928 and in several preceding years is given in the table that follows. From the beginning of operations through 1928 Jerome ranks sixth among the country's copper-producing districts. The chief producers of the district are the United Verde Copper Co. and the United Verde Extension Mining Co.

Copper produced in Yavapai County, Ariz., 1919-1928, in pounds

1919.....	80,227,549	1924.....	143,348,230
1920.....	114,937,080	1925.....	154,017,340
1921.....	26,576,293	1926.....	155,368,000
1922.....	76,607,502	1927.....	141,642,000
1923.....	147,718,492	1928.....	165,297,000

From its mine during 1928 the United Verde Extension Mining Co. produced 256,170 dry tons of ore, averaging 8.85 per cent of copper, 1.62 ounces of silver, and 0.038 ounce of gold. Of this ore 246,399 tons was shipped to the smelter; the average yield was 8.96 per cent copper, 1.63 ounces of silver, and 0.038 ounce of gold per ton. In addition, the smelter treated 78 tons of custom ore. The copper produced at Clemenceau amounted to 43,977,853 pounds. The company also shipped silica ore which yielded 1,222,188 pounds of copper. It completed 19,509 feet of raises and drifts and 3,715 feet of diamond drilling. The reserves amounted to 778,620 tons of ore, averaging more than 8 per cent in copper. The cost was 7.50 cents per pound, excluding depreciation, taxes, and reserve to return capital (depletion). The company distributed dividends amounting to \$2,100,000, or \$2 per share.

Cost ³ of producing copper by United Verde Extension Mining Co. in 1928

	Cents per pound
Mining.....	2. 67
Smelting.....	2. 70
Freight on ore.....	. 09
Freight on bullion, refining, selling.....	1. 82
Other expenses.....	. 22
	7. 50

Copper produced by the United Verde Extension Mining Co., 1919-1928

Year	Ore treated	Copper produced	Silver	Gold
	<i>Short tons</i>	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>
1919.....	93, 325	28, 860, 615	272, 855	3, 169
1920.....	161, 617	41, 942, 700	359, 370	5, 530
1921.....	53, 643	12, 498, 005	112, 864	2, 328
1922.....	136, 980	31, 640, 714	238, 764	5, 788
1923.....	172, 629	41, 855, 959	257, 602	8, 992
1924.....	185, 858	44, 278, 947	(1)	(1)
1925.....	¹ 183, 309	43, 720, 324	(1)	(1)
1926.....	198, 911	43, 041, 576	(1)	(1)
1927.....	² 248, 799	41, 301, 930	(1)	(1)
1928.....	246, 477	45, 200, 041	(1)	(1)

¹ Figures not available.

² Includes 2,546 tons of custom concentrates smelted.

³ Includes 2,043 tons of custom ore smelted.

The mines and plants of the United Verde Copper Co. were active continuously throughout 1928.

Ray or Mineral Creek district.—In 1928 the Ray district produced 68,661,000 pounds of copper, compared with 62,860,000 pounds in 1927. The total recorded output of the district through 1928 is 1,018,793,000 pounds; it continued to rank tenth among the copper-producing districts of the country.

At the Ray mines of the Nevada Consolidated Copper Co. 3,234,600 tons of copper ore was treated in 1928, compared with 2,830,100 tons in 1927. Further data for the Ray mines have been blanketed under the main company, the Nevada Consolidated Copper Co., as given under Nevada (p. 744).

⁴ Exclusive of depreciation, reserve to return capital (depletion), and taxes.

Copper produced by Ray mines of the Nevada Consolidated Copper Co., Arizona, 1919-1928

Year	Ore milled	Copper content	Mill recovery	Refined copper
	<i>Short tons</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Pounds</i>
1919.....	1,621,600	1.814	79.45	46,011,371
1920.....	1,706,928	1.720	81.98	47,062,030
1921.....	406,172	1.646	77.82	10,110,131
1922.....	1,178,350	1.587	76.66	27,953,408
1923.....	2,689,800	1.571	74.87	61,385,205
1924.....	2,896,700	1.523	78.27	67,017,981
1925.....	3,037,700	1.500	84.45	74,691,091
1926.....	2,957,200	(1)	(1)	(1)
1927.....	2,830,100	(1)	(1)	(1)
1928.....	3,234,600	(1)	(1)	(1)

¹ Not given separately. In 1926 the copper content of Ray, Nevada, and Chino production was 1.263 per cent, mill recovery 86.26 per cent, and refined copper output 231,119,539 pounds; in 1927 copper content was 1.326 per cent, mill recovery 87.92 per cent, and refined copper output 218,683,930 pounds; in 1928 copper content was 1.363 per cent, mill recovery 86.56 per cent, and refined copper output 268,462,629 pounds.

Ajo district.—The New Cornelia Copper Co. mined 5,484,344 wet tons of ore and waste. A total of 2,571,918 dry tons of ore, containing 1.345 per cent of copper, was sent to the concentrator; 1,074,056 dry tons, containing 1.105 per cent of total copper, was sent to the leaching plant; 320,131 dry tons, containing 0.393 per cent of total copper, was sent to the sulphide waste dump; and 1,449,625 dry tons, containing 0.310 per cent of total copper, was sent to the carbonate waste dump. A total of 2,573,458 dry tons of sulphide ore was treated at the concentrating plant, a daily average of 7,070 tons, and 1,074,056 dry tons of carbonate ore was treated at the leaching plant, a daily average of 2,934.5 tons. The ores treated yielded 77,995,281 pounds of copper, 171,943 ounces of silver, and 16,379 ounces of gold. Extensive development work, principally drilling, has disclosed that the ore reserves are large enough to warrant an increase of milling capacity.

Copper produced by the New Cornelia Copper Co., 1924-1928, in pounds

	1924	1925	1926	1927	1928
Electrolytic copper.....	22,746,882	15,979,895	17,405,991	72,932,670	77,995,281
Cement copper.....	1,729,479	1,305,265	836,282		
Copper from concentrates.....	39,407,932	51,977,126	64,070,190		
	63,884,293	69,262,286	82,312,463	72,932,670	77,995,281

Silver Bell district.—The Silver Bell district produced 2,856,000 pounds of copper in 1928, compared with 2,442,000 pounds in 1927.

Pioneer district.—The mine of the Magma Copper Co. produced 263,094 tons of ore of all classes, averaging 7.19 per cent of copper, 3.42 ounces of silver, and 0.034 ounce of gold. The net metal output for the year, after deduction of losses including those of refining, was as follows:

	Copper	Silver	Gold
	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>
From the Magma mine.....	35,228,810	917,048	8,665
From purchased ore.....	1,229,319	193,319	3,114
	36,458,129	1,110,367	11,779

The mill heads averaged 6.52 per cent of copper, the tailings ran 0.18 per cent of copper, and the recovery was 98.38 per cent, indicating a slight increase in metallurgical efficiency. A total of 11,435 feet of development work was completed during the year, bringing the total to date to 141,170 feet. The mine is now opened down to the 2,960 level, and the station has recently been cut on the 2,800 level of No. 5 shaft.

CALIFORNIA

In California production of blister copper dropped from 25,802,603 pounds in 1927 to 24,707,992 pounds in 1928. However, California remained in eighth place in total production from the beginning of operations, the total output being 1,020,999,194 pounds, or 2.49 per cent of the country's total.

Shasta district.—The Shasta district produced 3,056,000 pounds of copper in 1928, compared with 4,525,000 pounds in 1927. The district has yielded a total of 627,380,000 pounds through 1928 and ranks eleventh in total production among the copper-producing districts of the country.

Foothill district.—The Foothill district produced 148,000 pounds of copper in 1928, bringing the total output through 1928 to 172,359,000 pounds.

Plumas district.—In 1928 the Plumas district produced 21,141,000 pounds of copper, compared with 21,055,000 pounds in 1927. The Engels Copper Mining Co. is the most important producer in the district.

The Engels Copper Mining Co. produced 11,137,234 pounds of copper in 1928, compared with 12,121,756 pounds in 1927. In addition, 113,549 ounces of silver and 1,767 ounces of gold were produced in 1928. The total production of copper since the beginning of operations by the company in 1914 has reached 144,907,878 pounds. The grade of the ore mined in 1928 was 1.710 per cent copper, compared with 1.788 per cent in 1927. The ore reserves decreased from 777,034 tons, averaging nearly 2 per cent, in 1927 to 556,837 tons in 1928. The mill treated 357,564 dry tons of ore, assaying 1.71 per cent of copper; the yield was 40,077,748 pounds of concentrates, which assayed 27.789 per cent of copper.

Cost of producing copper by Engels Copper Mining Co. in 1928

	Total	Per pound of copper
		<i>Cents</i>
Operating cost.....	\$827, 652. 15	7. 4314
Freight and smelting charges..... \$527, 736. 08		
Credit value of gold and silver recovered..... 96, 289. 30		
	431, 146. 78	3. 8712
Operating and marketing cost.....	1, 258, 793. 93	11. 3026
Depreciation costs.....	79, 125. 75	. 7105
Development amortization.....	425, 959. 14	3. 8246
	1, 763, 883. 82	15. 8377

Operations at Superior mill in 1928

Ore milled.....	short tons..	357, 564
Average heads.....	per cent..	1. 710
Average tails.....	do.....	. 187
Actual extraction.....	do.....	91. 58
Concentrates produced.....	pounds..	40, 077, 748
Average content of concentrates.....	per cent..	27. 79
Copper produced.....	pounds..	11, 137, 234
Silver produced.....	ounces..	113, 549. 37
Gold produced.....	do.....	1, 767. 333

Ore reserves of Engels and Superior mines, December 31, 1928, in short tons ¹

Mine	Blocked ore		Probable ore	Total
	In place	Broken in stopes		
Engels.....	331, 187	104, 444	36, 816	472, 447
Superior.....	78, 154	6, 236	-----	84, 390
	409, 341	110, 680	36, 816	556, 837

¹ This estimate of ore reserves represents ore that assays approximately 2 per cent in copper.

Operations by the Walker Mining Co., a subsidiary of Anaconda, were continuous throughout the year; 486,156 tons of ore was broken; and 391,275 tons of ore was treated in the concentrator, yielding 22,653.7 tons of concentrates. The concentrates averaged 22.755 per cent of copper and the mill heads 1.443 per cent. The company sold to the smelter 22,544.86 tons of concentrates, which yielded 9,613,856 pounds of fine copper, 202,314 ounces of silver, and 13,011 ounces of gold. The concentrator made an average recovery of 91.294 per cent.

COLORADO

Colorado continued to hold tenth place among the copper-producing States of the country both for 1928 and for total recorded production through 1928. In 1928 the production amounted to 10,262,083 pounds, as compared with 8,006,801 pounds in 1927; practically the entire output was obtained as a by-product from siliceous ores and lead-zinc ores. To date no highly important copper mine has been opened in the State. The total production through 1928 is 328,832,-818 pounds, 0.8 per cent of the country's total.

IDAHO

In 1928 the production of blister copper from Idaho amounted to 2,336,654 pounds, compared with 1,811,103 pounds in 1927, and the State continued to rank thirteenth among the copper-producing States. The total output from Idaho through 1928 is 133,231,240 pounds, and the State continues to rank eleventh.

MICHIGAN

Lake Superior district.—In the production of copper from the beginning of operations through 1928 Michigan ranks third among the States, with 8,053,995,921 pounds, or 19.62 per cent of the

country's total output of 41,051,624,027 pounds. The 1928 smelter production amounted to 179,104,311 pounds, or 9.81 per cent of the country's total, as compared with 195,135,199 pounds in 1927, or 11.59 per cent of the country's total. The Lake Superior district ranks second only to the Butte district in total mine output through 1928, having produced 8,014,372,000 pounds compared with 9,638,796,000 pounds from the Butte district. In 1928 the Lake Superior district ranked third in mine output, with 178,443,000 pounds of copper.

Copper ore produced in Lake Superior district, Michigan, 1919-1928

Year	Short tons	Yield of copper (per cent)	Year	Short tons	Yield of copper (per cent)
1919.....	7,690,253	1.16	1924.....	5,372,572	1.26
1920.....	5,938,967	1.30	1925.....	7,036,751	1.10
1921.....	3,610,648	1.20	1926.....	7,641,682	1.15
1922.....	4,952,264	1.23	1927.....	8,016,334	1.10
1923.....	5,363,160	1.29	1928.....	7,361,658	1.21

The mines of the Calumet & Hecla Consolidated Copper Co. produced 91,308,000 pounds of copper in 1928 at an average cost of 10.10 cents per pound, including cost of selling but no charges for depreciation and depletion, as compared with 80,043,000 pounds at a cost of 10.45 cents in 1927. In addition, during the same period the reclamation plants at Lake Linden and Hubbell produced 29,896,000 pounds of copper at an average cost sold of 5.95 cents per pound, as compared with 28,717,000 pounds at a cost of 6.63 cents in 1927. The Calumet mill treated 813,760 tons of conglomerate and 262,200 tons of Osceola amygdaloid, while the Ahmeek mill treated 1,273,897 tons from the Kearsarge mine and 665,565 tons of Osceola amygdaloid. The smelter received 103,600 tons of concentrates and mass copper and smelted 102,939 tons, all of which came from the mines and mills of the company. The yield from these concentrates was 121,527,000 pounds of refined copper.

Operations at the Calumet & Hecla reclamation plants at Lake Linden and Hubbell in 1928 and for the entire period of their operation

	1928	Since starting
Quantity treated.....short tons.....	2,629,000	20,779,000
Assay headings.....per cent.....	0.666	0.669
Assay tailings.....do.....	0.094	0.146
Refined copper produced.....pounds.....	29,896,000	217,288,000
Refined copper produced per ton treated.....do.....	11.37	10.46

The comparative results of operations during the past four years by the Isle Royale Copper Co. are summarized as follows:

Copper produced by the Isle Royale Copper Co., 1925-1928

	1925	1926	1927	1928
Rock hoisted.....short tons..	497, 124	564, 692	593, 594	560, 598
Rock-house discard.....do.....	118, 665	116, 945	128, 494	119, 867
Rock treated.....do.....	378, 459	447, 747	465, 100	440, 731
Cost of mining, transportation, stamping, and taxes per ton of rock.....	\$2. 62	\$2. 39	\$2. 50	\$2. 71
Refined copper produced.....pounds..	9, 543, 000	11, 017, 000	11, 391, 338	10, 520, 771
Refined copper per ton of rock treated.....do....	25. 22	24. 61	24. 49	23. 87

The Baltic, Champion, and Trimountain mines produced 24,254,132 pounds of refined copper in 1928, of which 14,472,364 pounds was for the Copper Range Co.; one-half of the output of the Champion belonged to the St. Mary's Mineral Land Co. There was 558,932 tons of rock stamped which yielded, after stamping, an average of 43.39 pounds of copper per ton, compared with 38.27 pounds per ton in 1927.

The Champion Copper Co. stamped 427,240 tons of rock, from which 19,563,535 pounds of copper was obtained, or an average yield of 45.79 pounds per ton. The Baltic mine stamped 92,742 tons of material, from which 3,415,082 pounds of copper was obtained, or a yield of 36.82 pounds per ton. The Trimountain mine stamped 38,950 tons of rock, yielding 1,275,515 pounds of copper, or 32.74 pounds per ton. The reserves at the Champion mine were increased by development work during the year; those at the Baltic and Trimountain mines remained about the same. At the Champion mine development work was done on the 29th, 31st, 33rd, and 35th levels of No. 1 shaft as well as in Nos. 3 and 4 shafts. The reserves were further increased by better market conditions, which rendered lower grade ore profitable.

Copper produced by the Champion Copper Co., 1919-1928

Year	Rock stamped	Copper produced	Yield per ton	Cost per pound ¹	Price received	Net profits
	<i>Short tons</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Cents</i>	<i>Cents</i>	
1919.....	503, 030	19, 886, 917	39. 534	11. 62	18. 67	\$1, 399, 714. 19
1920.....	321, 664	13, 610, 324	42. 419	14. 40	17. 17	399, 772. 65
1921.....	531, 780	20, 719, 307	39. 018	9. 82	13. 329	719, 955. 51
1922.....	503, 593	19, 583, 806	38. 964	9. 93	14. 359	890, 515. 16
1923.....	449, 130	18, 412, 630	41. 03	11. 14	14. 86	738, 871. 98
1924.....	457, 160	20, 061, 630	43. 88	10. 49	13. 76	709, 276. 53
1925.....	414, 645	17, 957, 605	43. 308	11. 73	14. 258	497, 764. 43
1926.....	454, 654	17, 658, 820	38. 84	10. 83	13. 948	597, 042. 27
1927.....	403, 260	16, 098, 926	39. 92	10. 84	13. 42	455, 791. 07
1928.....	427, 240	19, 563, 535	45. 79	11. 10	15. 01	829, 357. 45

¹ Excludes depreciation and depletion.

Copper produced by the Baltic mine, 1919-1928

Year	Rock stamped	Copper produced	Yield per ton	Cost per pound ¹	Price received	Net profits
	<i>Short tons</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Cents</i>	<i>Cents</i>	
1919.....	235, 832	7, 864, 653	33. 35	17. 53	18. 67	\$89, 305. 51
1920.....	175, 357	6, 613, 918	37. 71	18. 02	17. 11	² 59, 882. 60
1921.....	195, 816	7, 608, 847	38. 86	14. 15	13. 078	² 81, 668. 95
1922.....	165, 804	5, 329, 568	32. 14	16. 76	13. 958	² 149, 578. 09
1923.....	137, 801	4, 877, 248	35. 51	18. 42	14. 626	² 189, 880. 94
1924.....	150, 101	4, 769, 286	31. 77	15. 95	13. 76	² 104, 574. 24
1925.....	140, 958	4, 255, 069	30. 18	17. 74	14. 25	² 148, 517. 14
1926.....	126, 157	3, 690, 041	29. 25	18. 28	13. 94	² 160, 073. 52
1927.....	121, 504	4, 207, 819	34. 63	13. 50	13. 42	² 3, 120. 98
1928.....	92, 742	3, 415, 082	36. 82	14. 54	15. 01	16, 085. 53

¹ Excludes depreciation and depletion.

² Deficit.

Copper produced by the Trimountain mine, 1919-1928

Year	Rock stamped	Copper produced	Yield per ton	Cost per pound ¹	Price received	Net profits
	<i>Short tons</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Cents</i>	<i>Cents</i>	
1919.....	171,995	5,274,387	30.66	19.39	18.668	\$51,303.34
1920.....	116,768	3,532,025	30.24	25.51	17.115	² 247,390.52
1921.....	143,172	4,341,584	30.32	18.27	13.078	² 183,560.50
1922.....	130,913	4,116,100	31.44	16.47	13.95	² 67,576.58
1923.....	6,273	281,482	44.87	(³)	14.62	² 140,563.74
1924.....	8,159	278,259	34.10	(³)	13.76	² 87,053.47
1925.....	35,465	1,065,044	30.03	(³)	14.25	² 39,302.47
1926.....	63,837	2,177,416	34.11	13.43	13.94	11,253.16
1927.....	67,281	2,354,808	35.00	12.25	13.42	27,476.86
1928.....	38,950	1,275,515	32.74	16.90	15.01	² 24,100.34

¹ Excludes depreciation and depletion.² Deficit.³ Figures not given.

The Mohawk Mining Co. produced 676,436 tons of rock, of which 656,739 tons was stamped. The rock stamped yielded 30,002,000 pounds of mineral from which was produced 21,243,265 pounds of refined copper. The rock treated averaged 32.346 pounds of copper to the ton, as compared with 29.116 pounds in 1927. The total cost of delivered refined copper during the year was 7.623 cents per pound.

Copper produced by the Mohawk Mining Co. in 1928

Rock hoisted.....	short tons..	676,436
Rock stamped.....	do.....	656,739
Product of mineral.....	pounds..	30,002,000
Refined copper produced.....	do.....	21,243,265
Yield per ton of rock treated.....	do.....	32.346
Cost per ton of rock hoisted.....		\$1.832
Cost per ton of rock stamped.....		\$1.887
Operating cost per pound of refined copper.....	cents..	5.835
Cost of taxes.....	do.....	.269
Cost of smelting, freight, and marketing product, including eastern offices' expenses.....	cents..	1.519
		7.623

In 1928 the Quincy Mining Co. produced 1,891,200 pounds of mineral, yielding 1,220,536 pounds of refined copper. Development work done through No. 6 shaft amounted to 10,652 feet. Of the 60,834 tons of rock stamped 22,659 tons was produced from drifts on the lodes. New ore has been developed in No. 2 shaft, some of which is relatively good.

Copper produced by the Quincy Mining Co., 1924-1928

Year	Copper rock and mass	Mineral	Copper	Yield of copper per ton of rock
	<i>Short tons</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1924.....	588,100	24,489,920	14,838,633	25.24
1925.....	586,913	22,721,380	14,357,523	24.46
1926.....	517,900	20,220,795	13,290,052	25.66
1927.....	413,000	15,336,690	9,718,662	23.53
1928.....	60,834	1,891,200	1,220,536	20.06

MISSOURI

During 1928 Missouri produced only 930 pounds of blister copper, as compared with 5,041 pounds in 1927.

MONTANA

Among the copper-producing States Montana stands second only to Arizona in total recorded production through 1928. In 1928 Montana ranked third among the copper-producing States. The smelter output of the State was 251,046,415 pounds in 1928, or 13.75 per cent of the nation's total, and the total output through 1928 is 9,704,543,923 pounds, or 23.64 per cent of the country's total. Montana has only one outstanding copper-producing district—the Butte.

Butte district.—The Butte district continues as the leading district in the United States in total production of copper since the beginning of operations. Through 1928 Butte has produced a total of 9,638,796,000 pounds of copper; it produced 247,067,000 pounds in 1928, compared with 221,312,000 pounds in 1927. The Anaconda Copper Mining Co. is by far the most important producer in the district. The output of the Butte district for a number of years is given in the following table.

Copper and associated metals produced in Butte district, Montana, 1919–1928

Year	Copper	Gold	Silver	Year	Copper	Gold	Silver
	<i>Pounds</i>		<i>Ounces</i>		<i>Pounds</i>		<i>Ounces</i>
1919.....	169,051,000	\$576,756	10,527,457	1924.....	247,364,000	\$730,646	11,859,290
1920.....	176,399,000	643,595	10,570,676	1925.....	266,637,000	746,422	11,561,659
1921.....	47,958,000	280,085	4,980,285	1926.....	252,991,000	678,290	11,058,861
1922.....	165,374,000	540,936	10,394,811	1927.....	221,312,000	540,827	9,658,204
1923.....	223,043,000	624,528	11,835,643	1928.....	247,067,000	595,495	9,558,587

The Butte mines of the Anaconda Copper Mining Co. produced 3,013,495 tons of copper ore and precipitates during 1928. At the concentrator 2,975,206 tons of copper ore, including some custom ore, was treated. The Anaconda smelter treated 648,940 tons of cupreous material, from which 247,577,554 pounds of copper, 6,165,123 ounces of silver, and 36,564 ounces of gold were obtained. The refinery at Great Falls produced 263,141,497 pounds of copper cathodes, of which 252,679,922 pounds were melted into shapes.

Copper, gold, and silver produced by Anaconda Copper Mining Co. from company ores, 1919–1928

Year	Copper ore treated	Copper	Silver	Gold	Dividend
	<i>Short tons</i>	<i>Pounds</i>	<i>Ounces</i>	<i>Ounces</i>	
1919.....	1,794,358	129,781,031	6,744,262	42,526	\$9,325,000
1920.....	1,828,380	138,763,065	6,420,026	32,530	6,993,750
1921.....	895,239	32,267,345	2,137,062	8,619	-----
1922.....	1,878,162	141,741,235	6,755,212	25,720	-----
1923.....	2,735,534	200,779,688	8,568,607	29,726	9,000,000
1924.....	3,017,417	238,247,038	8,345,841	37,689	2,250,000
1925.....	2,750,736	266,373,956	9,054,741	38,390	9,000,000
1926.....	2,570,162	254,302,568	8,226,724	31,764	9,000,000
1927 ¹	2,866,785	221,300,270	6,638,127	32,674	9,000,000
1928 ¹	2,975,206	247,577,554	6,165,123	36,564	14,419,034

¹ Reported in 1927 and 1928 as tonnage treated in plant and production, including purchased and toll material.

The Butte & Superior Mining Co. in 1928 produced 11,541 dry tons of copper ore, the metal content of which was as follows: Copper, 833,393 pounds (3.61 per cent); gold, 54 ounces; silver, 76,975 ounces; lead, 59,506 pounds; zinc, 774,921 pounds. In addition, the company produced 260,712 dry tons of zinc ore, which contained 2,163 ounces of gold, 1,652,608 ounces of silver, 1,031,709 pounds of copper, 6,837,281 pounds of lead, and 66,465,833 pounds of zinc. The reserves at the beginning of 1928 amounted to 178,280 tons of zinc ore, averaging 15.24 per cent zinc and 5.47 ounces silver, and 4,214 tons of copper ore, averaging 3.36 per cent copper and 6.63 ounces silver. The reserves at the end of 1928 were given as 151,924 tons of zinc ore and no copper ore of commercial grade.

The East Butte Copper Mining Co. mined 110,997 dry tons of copper ore, from which were obtained 8,537,068 pounds of copper, 389,860 ounces of silver, and 1 ounce of gold. In addition, 41 tons of copper precipitates at the Pittsmtont mine, assaying 62.53 per cent of copper, yielded 47,565 pounds of copper. The company did 4,244 feet of development work during 1928 on the 800, 2,000, 2,200, 2,400, and 2,600 foot levels. Some new ore was disclosed during the year.

Copper operations of East Butte Copper Mining Co. in 1928

Ore mined (dry weight), Pittsmtont.....	short tons..	110, 997
Average assay value, copper.....	per cent..	4. 41
Average assay value, silver.....	ounces..	4. 04
Copper produced.....	pounds..	8, 537, 068
Silver produced.....	ounces..	389, 860
Gold produced.....	do.....	1
Copper precipitates produced (dry weight), Pittsmtont.....	short tons..	41
Average assay value.....	per cent..	62. 53
Copper produced.....	pounds..	47, 565
Price per pound copper received.....	cents..	14. 505
Cost per pound copper delivered.....	do.....	13. 870
Profit per pound.....	do.....	. 635

NEVADA

In 1928 Nevada produced 159,332,977 pounds of copper, 18.73 per cent of the total for the country, and again ranked fifth among the copper-producing States. From the beginning of operations through 1928 Nevada has produced 1,582,495,103 pounds, or 3.86 per cent of the country's total, and also ranks fifth. Most of the copper produced in Nevada comes from the Ely (Robinson) district.

Ely (Robinson) district.—The mine production in the Ely district in 1928 amounted to 141,969,000 pounds, as compared with 107,441,000 pounds in 1927. Through 1928 this district has produced a total of 1,411,534,000 pounds, or 3.44 per cent of the country's total, and ranks eighth among the districts. The Nevada Consolidated Copper Co. produces most of the output of the district and the State.

Production of metals in Ely (Robinson) district, Nevada, 1919-1928

[Mine figures]

Year	Ore	Copper produced	Average yield in copper	Gold and silver per ton of ore
	<i>Short tons</i>	<i>Pounds</i>	<i>Per cent</i>	<i>Cents</i>
1919.....	2, 273, 961	47, 871, 048	1. 05	17
1920.....	2, 589, 546	48, 347, 828	. 93	21
1921.....	400, 810	10, 282, 527	1. 28	25
1922.....	630, 871	22, 614, 736	1. 79	19
1923.....	2, 833, 674	65, 928, 279	1. 16	24
1924.....	3, 505, 362	73, 279, 064	1. 05	21
1925.....	3, 922, 770	78, 627, 308	1. 00	21
1926.....	4, 672, 240	95, 009, 115	1. 02	18
1927.....	4, 488, 009	107, 441, 000	1. 20	24
1928.....	5, 730, 471	141, 969, 000	1. 24	28

At the Nevada mines of the Nevada Consolidated Copper Co. 4,664,018 dry tons of ore was taken from the shovel pits and underground workings and delivered to the mill. This, with 941,942 dry tons of custom ore, brought the total ore concentrated up to 5,605,960 dry tons, an average of 15,359 tons daily; the cost of milling, exclusive of depreciation and taxes but including all other expenses, was 46.6 cents per ton. At the company's Ray mines, in Arizona, 3,234,600 dry tons of ore, or an average of 8,862 tons per day, was handled in the Hayden concentrator at a cost of 39.9 cents per ton. At the company's Chino mines, in New Mexico, a total of 3,596,144 dry tons, or an average of 9,852 tons per day, was handled, all of which went through the Hurley concentrator; the milling cost, exclusive of depreciation and taxes, was 55.4 cents. The total ore milled at the three properties and on all accounts was 12,436,704 tons, or an average of 34,073 tons per day. The average grade of all company ore handled by the company was 1.363 per cent copper, and the average recovery in the form of concentrates was 86.56 per cent of the total copper content. This amounted to 23.60 pounds of copper per ton of ore treated. The total ore produced from the company's mines during the year amounted to 11,607,547 tons; of this total 11,494,762 tons was concentrated, or an average of 31,492 tons per day, and 112,785 tons was shipped direct to the smelters. The total yield of company copper was 268,462,629 pounds. The company reports an approximate ore reserve of 267,000,000 tons for the three mines.

Metals produced by the Nevada mines of the Nevada Consolidated Copper Co., 1919-1928

Year	Ore treated	Average assay of copper	Average extraction of copper	Refined copper produced
	<i>Short tons</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Pounds</i>
1919.....	2, 135, 425	1. 599	70. 49	43, 971, 892
1920.....	2, 568, 588	1. 449	70. 20	48, 311, 985
1921.....	392, 645	1. 49	75. 23	9, 362, 325
1922.....	518, 523	1. 60	75. 19	23, 762, 675
1923.....	2, 576, 388	1. 31	82. 90	61, 573, 246
1924.....	3, 418, 900	1. 198	87. 09	70, 237, 050
1925.....	¹ 3, 234, 390	¹ 1. 21	92. 24	73, 653, 886
1926.....	² 4, 568, 272	(3)	(3)	(3)
1927.....	⁴ 4, 376, 295	(3)	(3)	(3)
1928.....	⁵ 5, 605, 960	(3)	(3)	(3)

¹ In addition, 598,114 dry tons of porphyry sulphide material, averaging 0.684 per cent copper, was concentrated, giving a recovery in electrolytic copper of 9.63 pounds to a ton milled.

² Includes 208,143 tons of custom ore.

³ Not given separately. In 1926 the copper content of Ray, Nevada, and Chino production was 1.268 per cent, mill recovery 86.26 per cent, and refined copper output 231,119,539 pounds; in 1927 copper content was 1.326 per cent, mill recovery 87.92 per cent, and refined copper output 218,683,930 pounds; in 1928 copper content was 1.363 per cent, mill recovery 86.56 per cent, and refined copper output 238,462,629 pounds.

⁴ Includes 600,502 tons of custom ore.

⁵ Includes 941,942 tons of custom ore.

The Consolidated Coppermines Corporation in 1928 produced 21,551,936 pounds of copper, 14,097 ounces of gold, 36,853 ounces of silver, and 19,405 pounds of lead from 961,487 tons of ore averaging 1.39 per cent of copper. Most of the tonnage mined came from the Morris-Brooks, Ora, and Richard mines. A total of 18,128 feet of development work was done in 1928. It disclosed new bodies of lead-silver and copper ores.

Yerington district.—The Mason Valley Mines Co. produced 130,307 tons of mill ore, averaging 1.76 per cent of copper, at a total cost of \$1.02 per ton delivered to the mill bins, and 6,849 tons of 2.4 per cent copper carbonate ore, shipped to the smelter. Development work consisted of 237 feet of drifts and 538 feet of raises. At the end of the year the property had available about 400 tons of mill ore per day for another three months. The Bluestone group operated without interruption throughout the year and produced 345,541 tons of mill ore averaging 1.13 per cent of copper. The overburden removed during the year amounted to 26,047 tons, of which 12,310 tons of material of better grade averaging 1.57 per cent of copper was shipped to the smelter to replace lime rock for fluxing purposes. At the end of the year the property was expected to produce 650 tons of mill ore daily for the next three months. The mill operated throughout the year (at full capacity for 87.8 per cent of the time), treating 475,848 tons, or 1,300 tons per day, of 1.3 per cent copper ore, at a cost of 59 cents a ton. The mill recovery averaged 91.27 per cent of the sulphide copper and 86.33 per cent of the total copper. The ore yielded 41,556 tons of concentrates, which averaged 0.31 ounce of silver and 12.92 per cent of copper. The smelter handled 132,518 tons of marginal ore, of which 80,798 tons came from company properties. From these ores 8,772 tons of blister copper was obtained, containing 16,831 ounces of gold, 251,088 ounces of silver, and 17,334,240 pounds of copper.

NEW MEXICO

From the beginning of operations to the end of 1928 New Mexico has produced 1,212,851,320 pounds of copper, or 2.95 per cent of the country's total output of 41,051,624,027 pounds, and ranks sixth among the producing States. New Mexico ranked sixth also in production in 1928, with an output of 92,777,233 pounds, or 5.08 per cent of the country's total. The Santa Rita district produces most of the copper from New Mexico, and the Chino mines of the Nevada Consolidated Copper Co. furnish most of the district production.

Central (including Santa Rita) district.—The Central district, with a production of 1,067,631,000 pounds from the beginning of operations through 1928, ranks ninth among the copper-producing districts. The production for several years is shown in the following table.

Copper produced in Central (including Santa Rita) district, New Mexico, 1919–1928, in pounds

[Mine figures]

1919.....	40, 359, 000	1924.....	66, 824, 000
1920.....	44, 400, 000	1925.....	68, 812, 000
1921.....	9, 138, 000	1926.....	75, 219, 000
1922.....	28, 408, 000	1927.....	66, 971, 000
1923.....	54, 375, 000	1928.....	80, 239, 000

The Chino branch of the Nevada Consolidated Copper Co. concentrated 3,596,144 dry tons of ore in 1928, a daily average of 9,852 tons. The cost of milling, exclusive of taxes and depreciation, was 55.4 cents a ton. The haulage shaft, for the anticipated underground mining operations, was sunk to a depth of 661 feet to the main haulage level; 3,984 feet of development work was completed in the underground section. No underground production is anticipated for at least two years, as the pit operation is in good condition to continue as at present. The cost of open-pit mining was 32.22 cents per ton and that of stripping operations, 51.98 cents per cubic yard. The Hurley concentrator has been undergoing improvements; its capacity will reach 15,000 tons per day when the work is completed. Further data for the Chino mines have been blanketed under the main company, as given under Nevada (p. 744).

Metals produced by Chino mines of the Nevada Consolidated Copper Co., New Mexico, 1919–1928

Year	Ore milled	Copper content	Mill recovery	Refined copper produced
	<i>Short tons</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Pounds</i>
1919.....	1, 765, 200	1. 82	65. 67	40, 488, 760
1920.....	1, 838, 140	1. 76	70. 67	44, 051, 849
1921.....	361, 660	1. 70	77. 36	9, 137, 282
1922.....	1, 416, 869	1. 55	66. 99	28, 406, 314
1923.....	2, 785, 564	1. 50	66. 34	54, 261, 228
1924.....	2, 706, 200	1. 59	77. 83	66, 574, 486
1925.....	3, 002, 700	1. 42	80. 54	67, 385, 620
1926.....	3, 523, 319	(1)	(1)	(1)
1927.....	2, 982, 137	(1)	(1)	(1)
1928.....	3, 596, 144	(1)	(1)	(1)

¹ Not given separately. In 1926 the copper content of Ray, Nevada, and Chino production was 1.268 per cent, mill recovery 86.26 per cent, and refined copper output 231,119,539 pounds; in 1927 copper content was 1.326 per cent, mill recovery 87.92 per cent, and refined copper output 218,683,930 pounds; in 1928 copper content was 1.363 per cent, mill recovery 86.56 per cent, and refined copper output 268,462,629 pounds.

Lordsburg district.—The Eighty-Five branch of the Calumet & Arizona Mining Co. produced 93,672 wet tons of ore in 1928, averaging 2.74 per cent of copper. The production of the Lordsburg district for several years is given in the following statement.

Copper produced in Lordsburg district, New Mexico, 1919–1928, in pounds

[Mine figures]

1919.....	3, 516, 000	1924.....	4, 928, 000
1920.....	2, 696, 000	1925.....	5, 064, 000
1921.....	579, 000	1926.....	4, 763, 000
1922.....	3, 217, 000	1927.....	3, 933, 000
1923.....	4, 314, 000	1928.....	4, 625, 000

TENNESSEE

In 1928 Tennessee produced 16,374,261 pounds of blister copper, 0.9 per cent of the country's total, and again ranked ninth among the copper-producing States. From the beginning of operations through 1928 Tennessee also ranks ninth, having produced approximately 519,017,000 pounds of copper, or 1.26 per cent of the total output of the country. The entire output comes from the Ducktown district, in Polk County, in the extreme southeastern part of the State.

Copper produced in Ducktown district, Tennessee, 1919–1928

Year	Copper ore treated	Copper produced (smelter)	Average yield of copper	Gold and silver per ton of ore
	<i>Short tons</i>	<i>Pounds</i>	<i>Per cent</i>	<i>Cents</i>
1919.....	555, 018	15, 629, 454	1. 41	21
1920.....	589, 853	16, 727, 803	1. 42	21
1921.....	564, 457	15, 084, 294	1. 34	18
1922.....	557, 750	14, 226, 232	1. 28	15
1923.....	776, 477	18, 721, 932	1. 21	12
1924.....	714, 975	18, 251, 996	1. 28	10
1925.....	794, 930	19, 789, 234	1. 24	10
1926.....	608, 040	18, 601, 586	1. 53	12
1927.....	630, 955	14, 498, 951	1. 18	9
1928.....	759, 995	16, 374, 261	1. 08	7

In 1928 the Tennessee Copper Co. produced 13,585,853 pounds of copper and 69,265 tons of iron sinter. The production of sulphuric acid was the largest in the company's history, while other operations were near capacity. The ore reserves were estimated at 5,597,580 tons on January 1, 1929. The capacity of the flotation plant was increased to 900 tons daily, and the capacity of the smelter was also increased.

Copper and sulphuric acid produced by Tennessee Copper Co., 1919–1928

Year	Ore treated	Copper	Sulphuric acid, 60° Baumé	Year	Ore treated	Copper	Sulphuric acid, 60° Baumé
	<i>Short tons</i>	<i>Pounds</i>	<i>Short tons</i>		<i>Short tons</i>	<i>Pounds</i>	<i>Short tons</i>
1919.....	413, 877	10, 414, 815	266, 627	1924.....	451, 777	12, 726, 635	247, 477
1920.....	404, 060	10, 474, 881	333, 629	1925.....	516, 964	13, 625, 707	329, 395
1921.....	302, 584	8, 081, 322	242, 743	1926.....	506, 527	12, 566, 665	354, 722
1922.....	287, 499	7, 553, 281	218, 676	1927.....	420, 255	11, 063, 234	291, 393
1923.....	484, 324	12, 013, 988	299, 231	1928.....	(1)	13, 585, 853	(1)

¹ Not given.

UTAH

The smelter production of copper in Utah increased from 267,705,597 pounds in 1927 to 298,375,465 pounds in 1928. The 1928 production represented 16.34 per cent of the total United States output, and Utah again ranked second among the copper-producing States. From the beginning of operations through 1928 Utah has produced a total of 4,023,339,370 pounds of copper, 9.8 per cent of the total for the country, and ranks fourth among the copper-producing States. Utah, like most of the other copper-producing States, has one outstanding district—the Bingham.

Although about 275,000,000 pounds or nearly 90 per cent of the Utah copper production comes from the copper ore of the Bingham Canyon mine of the Utah Copper Co., nearly 11,350,000 pounds of copper was obtained during 1928 from the complex gold-silver-lead-zinc-copper ores of the Bingham, Park City, and Tintic districts. Among the important mines, those of the Utah-Apex, Park Utah Consolidated, Silver King Coalition, and the Bingham Mines companies each produced more than 1,000,000 pounds of copper.

Bingham district.—The Bingham district continued as the largest producing district in the country in 1928. In total production from the beginning of operations through 1928 this district ranks fourth, with an output of 3,623,262,000 pounds. The main producer of the district is the Utah Copper Co.

Copper produced in Bingham district, Utah, 1919–1928, in pounds

[Mine figures]

1919-----	116, 697, 000	1924-----	236, 181, 000
1920-----	110, 670, 000	1925-----	227, 612, 000
1921-----	28, 011, 000	1926-----	248, 975, 000
1922-----	91, 762, 000	1927-----	249, 919, 000
1923-----	216, 037, 000	1928-----	287, 685, 000

The Utah Copper Co. in 1928 produced and shipped to the mills 16,558,500 dry tons of copper ore, containing 0.992 per cent of copper, or 19.84 pounds per ton, a daily average of 45,742 tons. The average recovery in the form of concentrates was 85.56 per cent, or 16.97 pounds per ton, as compared with 89.12 per cent, or 17.45 pounds per ton, in 1927. The mills operated 362 days; the average milling cost was 36.9 cents per ton, as compared with 45.23 cents in 1927, a saving of 8.33 cents per ton. The concentrates shipped to the smelter averaged 31.53 per cent and contained 281,077,725 gross pounds of copper, as compared with 25.10 per cent and 240,964,666 pounds in 1927. Precipitates derived from mine waters and waste dump waters contained 1,976,851 pounds of copper and brought the gross production from all sources to 283,054,576 pounds, compared with 241,678,417 pounds in 1927. The net production of refined copper in 1928 was 273,823,351 pounds. The cost of all operations, as usually figured, including depreciation and all general expenses (except Federal taxes) and crediting gold, silver, and miscellaneous earnings, was 6.38 cents per pound, as compared with 7.54 cents per pound in 1927. A total of 176,144,651 tons of ore has been mined to date, and the total reserves on December 31, 1928, amounted to 625,000,000 tons, averaging 1.066 per cent of copper. This indicates that there will have been mined in all about 800,000,000 tons when the present reserves are

exhausted. Stripping of 7,220,034 cubic yards of overburden is included in the total of 31,864,335 tons of material, an average of 88,023 tons per operating day, removed from the mine in 1928.

Metals produced by Utah Copper Co. from ore milled, 1919-1928

Year	Ore milled	Copper content	Mill recovery	Copper ¹	Gold, silver, and miscellaneous income per pound of copper	Dividends (includes capital distribution)
	<i>Short tons</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Pounds</i>	<i>Cents</i>	
1919.....	5,538,700	1.26	78.46	105,088,740	² 0.83	\$9,746,940
1920.....	5,556,800	1.16	81.38	101,897,758	2.09	9,746,940
1921.....	1,220,700	1.16	83.87	24,511,593	1.15	4,061,225
1922.....	4,364,251	1.26	80.00	84,777,712	1.45	3,248,980
1923.....	11,167,800	1.12	80.96	195,142,919	1.313	6,497,960
1924.....	12,126,600	1.07	85.94	214,592,733	1.206	6,497,960
1925.....	12,538,300	1.02	86.96	214,162,139	1.36	6,904,083
1926.....	13,880,100	1.01	87.01	234,173,625	1.36	8,528,572
1927.....	13,811,500	.979	89.12	233,002,661	1.16	9,746,940
1928.....	16,558,500	.992	85.56	273,823,351	1.22	12,995,920

¹ Net production of refined copper, not copper content of concentrates.

² Exclusive of miscellaneous income.

Cost of mining, milling, and concentrating copper ore by Utah Copper Co., 1919-1928

Year	Ore (short tons)	Cost per ton			
		Mining	Transportation	Milling	Total
1919.....	5,538,700	\$0.4900	\$0.3040	\$1.2062	\$2.0002
1920.....	5,556,800	.4823	.2591	1.2472	1.9886
1921.....	1,220,700	.4998	.1921	1.1679	1.8598
1922.....	4,364,251	.3833	.1612	.8417	1.3862
1923.....	11,167,800	.3488	.1088	.6116	1.0692
1924.....	12,126,600	.3605	.1308	.5990	1.0903
1925.....	12,538,300	.3373	.1151	.5382	.9906
1926.....	13,880,100	.3139	.1019	.4843	.9001
1927.....	13,811,500	.3734	.0926	.4523	.9183
1928.....	16,558,500	.3178	.0874	.3690	.7742

The Ohio Copper Co. produced 3,973,282 pounds of copper in 1928, compared with 4,825,587 pounds in 1927. The cost per pound of refined copper was 11.4275 cents, compared with 10.2548 cents in 1927. A survey was made recently of the tailings dump, and its estimated contents were calculated as 4,995,459 tons containing 0.475 per cent of copper, or 47,405,671 pounds. Preliminary experimental work indicates that this ore can be treated profitably, and further work is being done to develop the best method of handling the material. During the year 5,050 feet of development work was completed. Satisfactory mineralization was disclosed in several places.

Copper production of the Ohio Copper Co., of Utah, in 1928

	Copper produced	Cost per pound	Price per pound	Profit per pound	Operating profits
	<i>Pounds</i>	<i>Cents</i>	<i>Cents</i>	<i>Cents</i>	
First quarter.....	1, 125, 804	11. 0261	13. 7872	2. 7611	\$31, 083. 07
Second quarter.....	1, 040, 391	11. 1510	14. 1530	3. 0020	31, 231. 15
Third quarter.....	998, 299	11. 0458	14. 5225	3. 4767	34, 707. 23
Fourth quarter.....	808, 788	12. 8127	15. 5318	2. 7191	21, 991. 44
	3, 973, 282	11. 4275	14. 4228	2. 9953	119, 012. 89

¹ After adding miscellaneous income and deducting taxes, insurance, and other miscellaneous charges net profits were \$63,162.09. After allowances for depreciation and depletion, a loss of \$33,624.56 was deducted from surplus.

Tintic district.—The Tintic district produced 2,457,000 pounds of copper in 1928, compared with 3,783,000 pounds in 1927. From the beginning of operations through 1928 the district has yielded 178,846,-000 pounds of copper. The production for several years is shown, as follows:

Copper produced in Tintic district, Utah, 1919-1928, in pounds

[Mine figures]

1919.....	3, 251, 000	1924.....	3, 076, 000
1920.....	3, 003, 000	1925.....	4, 627, 000
1921.....	1, 570, 000	1926.....	5, 226, 000
1922.....	2, 295, 000	1927.....	3, 783, 000
1923.....	3, 033, 000	1928.....	2, 457, 000

REFINERY PRODUCTION

The refinery output of copper in the United States in 1928 was made by 10 plants—7 of these employed the electrolytic method and 3 employed the furnace process on Lake Superior copper.

Five of the large electrolytic refineries are on the Atlantic seaboard, and the three Lake refineries are on the Great Lakes; only two plants are west of the Great Lakes—one at Great Falls, Mont., and one at Tacoma, Wash. In addition to these refineries are the electrolytic plants at Ajo and Inspiration, Ariz., which make electrolytically refined copper directly from the liquors obtained from leaching operations; this copper is shipped as cathodes to eastern refineries, where it is melted and cast into merchant shapes, and is accounted for in the production reported from these eastern refineries. There are also numerous plants in different parts of the country that make a considerable output from old copper and from brass and other alloys of copper. The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

Refinery production from ores of domestic and foreign origin is shown in the table on page 752. The domestic figure is the one that is to be compared with smelter production from domestic sources, the main difference being the time factor explained in the introduction to this report; the figures for refinery production include copper that was mined some three months earlier than the beginning of the calendar year and smelted probably one or two months earlier.

CASTING AND PIG COPPER

Blister copper that is low in precious metals and free enough from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries so small a content of precious metals that, together with the added value of electrolytic copper, it will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals has been exported without further treatment and is probably consumed without electrolytic refining. Some of the districts produced a rather high grade of blister copper carrying a small amount of precious metals, and it is found profitable to market some of this copper without electrolytic refining. During 1928 the production of furnace-refined new casting copper from domestic and foreign sources amounted to 7,596,406 pounds. No unrefined pig and best select copper was reported as produced in 1928.

LAKE COPPER

Lake copper, as the term is used in this report, means the output of the Lake smelters. Ordinarily a considerable proportion of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or is sold as some brand of Lake copper. Since December, 1922, however, the electrolytic plant of the Calumet & Hecla Consolidated Copper Co. has not been in commission because the silver content of the copper was not sufficient to pay for its recovery. The production of Lake copper in 1928 amounted to 179,104,311 pounds.

ELECTROLYTIC COPPER

In 1928 the approximate production of electrolytic copper from primary materials of domestic origin amounted to 1,607,120,026 pounds and from materials of foreign origin to 693,787,036 pounds, and, in addition, production from secondary sources amounted to 191,323,029 pounds—a total electrolytic production of 2,492,230,091 pounds for 1928, compared with 2,294,591,076 pounds for 1927.

REFINED COPPER

The total output of new refined copper in 1928 was 2,487,607,779 pounds, an increase of 161,844,070 pounds over that in 1927. Adding to the new refined copper produced from domestic and foreign sources the imports of refined copper gives the new copper made available for consumption during the year. In the following table is shown also the production of secondary copper by the regular refineries, but not the output of plants that treat only secondary material; the latter is shown in the second table on page 752.

Primary and secondary copper produced by regular refining plants in the United States and imported, 1923-1928, in pounds

	1923	1924	1925	1926	1927	1928
Primary:						
Domestic 1—						
Electrolytic.....	1,302,454,492	1,499,223,447	1,533,995,439	1,553,041,424	1,520,076,181	1,607,120,026
Lake.....	137,691,306	145,333,227	138,029,764	172,372,304	195,135,199	179,104,311
Casting.....	24,019,197	29,657,925	10,870,144	5,883,433	3,740,819	5,573,050
	1,464,164,995	1,674,214,599	1,682,895,347	1,731,297,161	1,718,952,199	1,791,797,387
Foreign 1—						
Electrolytic.....	509,873,512	577,100,034	516,632,530	588,932,788	605,748,329	693,787,036
Casting and best select.....	5,797,109	8,761,377	5,045,947	2,255,427	1,063,181	2,023,356
Refinery production, new copper.....	1,979,835,616	2,260,076,010	2,204,573,824	2,322,485,376	2,325,763,709	2,487,607,779
Imports refined copper.....	2 160,711,227	145,909,958	99,773,546	170,565,766	103,279,082	84,730,630
Total new refined copper made available.....	2,140,546,843	2,405,985,978	2,304,347,370	2,493,051,142	2,429,042,791	2,572,338,409
Secondary:						
Electrolytic.....	85,297,052	104,281,430	140,349,541	163,061,465	168,766,566	191,323,029
Casting.....	46,141,409	50,536,678	58,010,653	62,056,941	41,102,000	41,322,776
	131,438,461	154,818,108	198,360,194	225,118,406	209,868,566	232,645,805
Grand total.....	2,271,985,304	2,560,804,086	2,502,707,564	2,718,169,548	2,638,911,357	2,804,984,214

¹ The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

² The figures of imports of refined copper from Chile in 1923 reported by the Chile Exploration Co. have been included in place of the figures of the Bureau of Foreign and Domestic Commerce for Chile, which undoubtedly are very low.

If the output of plants treating only secondary material is added to the production of the regular refining companies, the contribution from plants in the United States to the world's supply of copper for 1928 is found to be 3,560,400,000 pounds.

SECONDARY COPPER

Under secondary copper is considered material recovered from remelting old copper, copper scraps, and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. The canvass of plants producing secondary copper is made by J. P. Dunlop, of the Bureau of Mines, and the following figures are taken from his report on secondary metals in Mineral Resources.

Secondary copper recovered in the United States in 1928 and imports and exports of scrap brass and copper, in short tons

Copper as metal.....	230,000
Copper in alloys other than brass.....	95,000
	<u>325,000</u>
Copper from new scrap (not including brass).....	68,000
Copper from old scrap (not including brass).....	257,000
	<u>325,000</u>
Brass scrap remelted:	
New clean scrap.....	147,000
Old scrap.....	155,000
	<u>302,000</u>

Copper content of brass scrap (averaging about 70 per cent copper):

New clean scrap-----	102, 900
Old scrap-----	108, 500
	<u>211, 400</u>

Total copper produced from secondary sources (including copper content of brass scrap):

From new scrap-----	170, 900
From old scrap-----	365, 500
	<u>536, 400</u>

Imports of scrap brass-----	6, 077
Imports of scrap copper-----	5, 304
Exports of brass ingots, scrap, and old-----	42, 413
Exports of scrap copper-----	27, 733

Refined copper from secondary sources produced in the United States, 1919-1928, in pounds

1919-----	574, 380, 000	1924-----	776, 600, 000
1920-----	624, 920, 000	1925-----	840, 420, 000
1921-----	434, 600, 000	1926-----	959, 600, 000
1922-----	671, 800, 000	1927-----	980, 400, 000
1923-----	821, 800, 000	1928-----	1, 072, 800, 000

COPPER SULPHATE

The production of hydrous copper sulphate or bluestone by the copper refineries of the United States in 1928 was 44,463,270 pounds, having a copper content of 11,326,000 pounds, compared with 36,039,487 pounds, having a copper content of 9,180,000 pounds, in 1927.

STOCKS

Stocks of copper in the United States, January 1, 1920-1929, in pounds

Year	Refined copper	Blister and materials in process of refining	Year	Refined copper	Blister and materials in process of refining
1920-----	631, 000, 000	273, 000, 000	1925-----	243, 000, 000	393, 000, 000
1921-----	659, 000, 000	465, 000, 000	1926-----	124, 000, 000	432, 000, 000
1922-----	459, 000, 000	283, 000, 000	1927-----	146, 000, 000	455, 000, 000
1923-----	216, 000, 000	361, 000, 000	1928-----	171, 000, 000	401, 000, 000
1924-----	264, 000, 000	432, 000, 000	1929-----	114, 000, 000	423, 000, 000

IMPORTS AND EXPORTS

The imports of unmanufactured copper in 1928 amounted to 787,073,640 pounds. This exceeds by 7,631,837 pounds the previous record imports of unmanufactured copper, in 1926. Large quantities of unrefined copper were imported from the Belgian Congo, as well as from Canada, Chile, Mexico, and Peru, for refining in the United States, and large quantities of ore and concentrates were received from Canada, Chile, Cuba, Mexico, and Spain. The only important quantity of refined copper imported was from Chile. Virtually all of the ore and blister produced in Chile but not refined there is sent to the United States for treatment.

Copper (unmanufactured) imported into the United States, 1926-1928, in pounds

[General imports]

Country	Ore (copper content)	Concen- trates (copper content)	Matte and regulus (copper content)	Unrefined black blis- ter and converter copper in pigs or con- verter bars	Refined in ingots, plates, or bars	Old and scrap fit only for remanu- facture	Com- position metal, copper chief value
1926							
Africa:							
British South				52,601,821		2,967	
Portuguese—							
East		20,271		83,314,732	910,206		
Other				449,642		150	
Australia	248,646		140,720				
Canada	47,609,027	7,963,626	107,655	44,961,092	685	6,002,507	135,503
Chile	33,074,184	848,861	202,836	31,365,100	166,872,641	343,351	
Cuba	5,433,042	14,471,381				1,926,861	10,980
France	1,146,285	37,300	42,114	1,131,955			
Germany	107,742	623,836		216,325	59,387	205,171	70,273
Mexico	2,862,187	18,821,148	971,943	82,320,581	210,874	68,624	
Peru	1,066,055	358,562	99,945	93,907,544		6,579	
Spain	13,480,257			24,783,133			
United Kingdom	270,617	183,644	250,783	27,743,879	2,069,115	890,199	111,244
Venezuela	276	1,345,408				1,667	
Other	1,417,040	76,440	313,046	1,002,493	442,858	1,553,513	153,274
Total value	106,715,358 \$13,452,075	44,750,477 \$5,351,557	2,129,042 \$261,443	443,798,297 \$56,101,041	170,565,766 \$23,335,640	11,001,589 \$1,114,436	481,274 \$63,769
1927							
Africa:							
Belgian Congo	1,010			114,482,007			
Union of South Africa				2,697,436	165		
Australia	307,397						
Canada	40,496,764	10,537,756		51,480,389	825,843	5,639,111	
Chile	35,247,293	5,548,687	14,970	63,697,974	100,839,354	272,738	
Cuba	4,263,985	25,108,017		241,920	35,496	628,987	
France	123,081	89,808		123,309			300
Germany	342,342	115,785	68,896		557,701	165,932	57,342
Mexico	6,650,973	25,286,667	1,210,431	82,984,970		132,337	
Peru	1,989,847	19,112	84,896	101,870,992		73,744	
Spain	8,463,703						
United Kingdom	78,848	121,692	14,275	19,509,068	1,008,323	72,853	
Venezuela	136,572	1,364,366				37,880	
Other	1,226,553	910		1,505,948	11,200	454,530	
Total value	99,328,373 \$10,757,297	68,192,800 \$8,106,626	1,393,468 \$131,092	438,594,013 \$51,954,453	103,279,082 \$13,105,086	7,477,612 \$698,494	57,642 \$14,573
1928							
Africa:							
Belgian Congo				113,999,871			
British—							
East				4,701,706			
Union of							
South	721,110	54,160		2,868,195		31,200	
Mozambique				13,906,012			
Australia	315,987			54,000			
Canada	48,084,775	1,040,490		95,681,502	150,124	7,883,497	17,713
Chile	34,275,132	328,328	12,437	95,767,272	83,733,020	15,230	
Cuba	2,740,181	11,438,200				550,618	
France	275,790	128,269	40,842	52,120	33,506	27,537	
Germany	300,986	78,833		170,441	769,180	92,179	164,563
Mexico	7,756,953	26,296,272	2,536,922	95,691,530		87,887	
Peru	927,218		50,283	115,595,856			
Spain	9,054,542	59,387		279,639			
United Kingdom	202,217			3,668,875		1,383,251	
Venezuela						41,978	
Other	1,536,831	48,610		753,121	44,800	519,130	33,332
Total value	106,191,722 \$11,589,484	39,472,549 \$4,800,595	2,640,484 \$284,656	543,190,140 \$67,595,061	84,730,630 \$12,634,463	10,632,507 \$909,382	215,608 \$31,718

Copper (unmanufactured) imported into the United States, 1919-1928, in pounds

[General imports]

1919-----	429, 387, 594	1924-----	768, 813, 731
1920-----	485, 670, 691	1925-----	652, 971, 407
1921-----	350, 472, 611	1926-----	779, 441, 803
1922-----	541, 013, 220	1927-----	718, 322, 990
1923-----	676, 473, 338	1928-----	787, 073, 640

According to the Bureau of Foreign and Domestic Commerce, as shown in the following table, 3,832,777 pounds of copper in "ore, concentrates, composition metal, and unrefined copper" was exported in 1928. The chief item in this figure is blister copper. According to the copper producers, however, many times this amount of blister was exported. It develops that approximately 30,000,000 pounds of blister copper exported during 1928 has been incorrectly classified as "refined copper" in the compilation of customs statistics.

In 1928, as in 1927, the United States exported more copper to Germany than to any other country; the United Kingdom stood second in order of importance and France third. In 1926 the United Kingdom was first, with France second and Germany third. The exports (in millions of pounds) from the United States to the six leading importers of United States copper in 1928 were as follows: Germany 235, United Kingdom 217, France 177, Italy 120, Belgium 80, and Netherlands 76.

Copper exported from the United States, 1927 and 1928, in pounds

Country	Ore, concentrates, composition metal, and unrefined copper (copper content) ¹	Refined ¹		Old and scrap	Pipes and tubes	Plates and sheets	Wire (except insulated)	Insulated wire and cable	Other manufactures of copper
		Rods							
		Bars, ingots, or other forms							
1927									
Belgium.....	5,758,076	89,498,171	639,590	246,572	35	244,134	125	17,205	
Canada.....	30,003	15,443,902	16,639,221	5,354,847	2,014,079	1,801,415	536,436	1,692,577	
China.....		5,639,979		6,500	1,121	26,032	6,437	94,700	
Denmark.....		1,000,366	4,486,234			2,192	570	39,044	
France.....		111,957,106	764,249			347,380	25,206	140,880	
Germany.....		221,841,647		25,137,084	58,381	1,580,624	1,156,448	489,778	
India (British).....		5,994,354	109,936	366,530		561,770	374,332	489,209	
Italy.....		86,270,218		325,490			769	3,932	
Japan.....	165	24,475,434		5,555,025	335	4,680	219,143	136,589	
Netherlands.....	758,742	104,000,674	2,115,711	4,188,862			71,166	55,194	
Norway.....	142,676		1,854,744		661	19,921	36,396	10,573	
Spain.....	7,548					1,784	50,256	56,882	
Sweden.....		21,875,271	7,295	666,679	94		1,048	10,936	
Switzerland.....		280,386		157,060			2,071	7,059	
United Kingdom.....	536,775	182,365,499	23,032,771	2,158,968	20,223	606,133	233,785	1,205,595	
Other.....	2,090	45,814,761	8,967,678	99,346	1,043,636	948,920	7,574,367	18,043,151	
Total value.....	7,236,125	922,466,143	58,617,429	45,418,278	3,138,565	7,073,847	10,288,555	22,490,304	
	\$784,617	\$125,378,316	\$8,870,322	\$5,127,889	\$776,739	\$1,321,445	\$1,689,316	\$5,166,086	
1928									
Belgium.....		77,434,816	2,678,650	333,078	249	420	4,438	39,410	
Canada.....	154,093	21,161,866	25,033,498	5,015,354	2,369,599	2,420,475	1,743,056	2,664,428	
China.....		5,892,175		40,964		33,439	259,513	211,136	
Denmark.....		1,998,350	1,457,494		3,450	644	224,789	52,734	
France.....		171,440,871	1,166,340	3,715,460		112,366	120,287	114,233	
Germany.....	22,415	206,549,919	33,584	23,581,476	229	504,061	2,562,020	43,840	
India (British).....	2,041,492	2,443,157	324,209	449,130	10,267	279,695	525,157	293,034	
Italy.....	1,345,580	116,547,931	224,397	262,123	440	279,181	533,684	447,423	
Japan.....		32,895,333	47,572	10,421,220		19,031	237,401	102,699	
Netherlands.....	154,116	64,626,417	2,523,631	7,972,816		404,036	508,628	196,355	
Norway.....	72,527	2,405,799	2,602,047		5,762	1,939	258	20,730	
Spain.....		3,321,076	2,701	1,312,277		650	141,070	122,305	
Sweden.....		28,704,670	226,367		1,260		1,956	13,693	
Switzerland.....		705,289					1,438	4,988	
United Kingdom.....	41,754	185,816,840	26,954,825	2,082,591	25,448	724,996	193,159	1,015,801	
Other.....	800	28,126,947	8,047,860	238,847	1,137,316	1,238,504	8,628,871	14,308,296	
Total value.....	3,832,777	949,474,456	71,325,075	55,466,555	3,554,241	6,039,457	15,675,751	19,651,105	
	\$508,112	\$140,339,589	\$11,066,251	\$6,994,196	\$901,336	\$1,275,305	\$2,023,986	\$4,816,608	
									(²)
									\$1,296,996

¹ See text on preceding page.² Figures for quantity not recorded.

Copper exported from the United States, 1919-1928

Year	Pounds		Total value
	Metallic ¹	Total	
1919	515,595,019	516,627,775	\$117,417,055
1920	623,158,489	624,053,701	127,468,606
1921	628,415,714	628,804,750	85,351,923
1922	742,755,957	743,039,888	103,874,007
1923	828,854,827	829,314,002	129,219,975
1924	1,116,775,136	1,116,915,484	156,645,684
1925	1,082,369,439	1,084,208,532	161,165,820
1926 ²	960,220,112	965,685,264	139,853,365
1927 ²	1,069,493,121	1,076,729,246	149,114,730
1928 ²	1,121,186,640	1,125,019,417	168,525,383

¹ Exclusive of ore, concentrates, and composition metal, and in 1923-1928 of unrefined copper, figures for which are not separable from those for ore and concentrates.

² Exclusive of "Other manufactures of copper," valued at \$1,350,391 in 1926, \$1,098,886 in 1927, and \$1,296,996 in 1928; quantity not recorded.

Copper sulphate (blue vitriol) exported from the United States, 1919-1928

Year	Pounds	Value	Year	Pounds	Value
1919	9,140,673	\$928,291	1924	2,688,039	\$142,626
1920	3,783,409	306,899	1925	6,139,344	285,870
1921	3,582,933	217,491	1926	4,798,620	231,175
1922	5,250,556	256,432	1927	6,206,904	320,653
1923	2,290,905	130,213	1928	8,666,899	455,023

Brass and bronze exported from the United States, 1927 and 1928

	1927		1928	
	Pounds	Value	Pounds	Value
Ingots, scrap, and old	91,994,030	\$8,824,029	84,826,337	\$7,947,218
Bars and rods	2,618,150	410,361	1,994,683	394,545
Plates and sheets	893,149	238,492	2,409,043	510,885
Pipes and tubes	3,433,324	788,289	4,260,683	1,074,667
Pipe fittings and valves	3,278,304	1,806,776	4,042,351	2,076,033
Hardware of brass or bronze	(¹)	763,682	(¹)	671,327
Plumber's brass goods	713,112	394,139	968,952	540,566
Wire of brass or bronze	1,196,029	380,165	1,356,618	434,830
Brass wood screws	623,223	157,514	598,587	157,071
Other brass and bronze manufactures	(¹)	3,752,566	(¹)	3,810,737
		17,516,013		17,617,879

¹ Figures for quantity not recorded.

Unmanufactured brass exported from the United States, 1919-1928

[Ingots,¹ bars, rods, plates, and sheets]

Year	Pounds	Value	Year	Pounds	Value
1919	7,770,671	\$2,310,561	1924	4,529,257	\$740,993
1920	5,810,733	1,671,608	1925 ¹	7,975,053	1,359,594
1921	2,874,762	741,110	1926 ¹	4,754,827	884,907
1922	3,660,340	635,449	1927 ¹	5,511,299	648,853
1923	3,465,739	703,503	1928 ¹	4,403,726	905,430

¹ Exclusive of ingots in 1925-1928, figures for which are not separable from those for "scrap and old."

CONSUMPTION

As calculated by the method shown in the following table, the quantity of new copper consumed in a year is actually the amount of new copper withdrawn from available supply on domestic account. This method of computation is not accurate, as figures on consumers' stocks are not available and can not be taken into account. In addition, much copper withdrawn on domestic account is later exported in manufactured forms. The domestic withdrawals in 1928 totaled 1,608,538,878 pounds. These withdrawals exceeded by 38,402,671 pounds those in 1926, the previous postwar record year.

New refined copper withdrawn from total year's supply on domestic account, 1921-1928, in pounds

	1921	1922	1923	1924
Total supply of new copper.....	1,020,027,096	1,358,659,101	2,140,546,843	2,405,985,978
Stock at beginning of year.....	659,000,000	459,000,000	216,000,000	264,000,000
Total available supply.....	1,679,027,096	1,817,659,101	2,356,546,843	2,669,985,978
Copper exported.....	¹ 609,038,352	¹ 705,025,268	² 792,073,512	² 1,072,243,414
Stock at end of year.....	459,000,000	216,000,000	264,000,000	243,000,000
	1,068,038,352	921,025,268	1,056,073,512	1,315,243,414
Withdrawn on domestic account.....	610,988,744	896,633,833	1,300,473,331	1,354,742,564

	1925	1926	1927	1928
Total supply of new copper.....	2,304,347,370	2,493,051,142	2,429,042,791	2,572,338,409
Stock at beginning of year.....	243,000,000	124,000,000	146,000,000	171,000,000
Total available supply.....	2,547,347,370	2,617,051,142	2,575,042,791	2,743,338,409
Copper exported.....	² 1,022,335,279	² 900,914,935	² 981,083,572	² 1,020,799,531
Stock at end of year.....	124,000,000	146,000,000	171,000,000	114,000,000
	1,146,335,279	1,046,914,935	1,152,083,572	1,134,799,531
Withdrawn on domestic account.....	1,401,012,091	1,570,136,207	1,422,959,219	1,608,538,878

¹ Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.

² Includes refined copper in ingots, bars, rods, or other forms.

Adding the 1,072,800,000 pounds of secondary copper and copper in alloys produced during the year to the 1,608,500,000 pounds of new refined copper withdrawn on domestic account gives a total of about 2,681,300,000 pounds of new and old copper that was available for domestic consumption.

USES

No official data are available showing the quantity of copper that entered the different industries.

The following table shows the copper cast in different forms in 1928. It will be noted that the total is not the same as the production of refined copper.

Copper cast in different forms in the United States in 1928

Form	Pounds	Percentage
Wire bars.....	1,652,000,000	61.66
Cakes.....	362,000,000	13.51
Cathodes.....	353,000,000	13.18
Ingots.....	218,000,000	8.14
Other forms.....	94,000,000	3.51
	2,679,000,000	100.00

PRICES

Reports to the Bureau of Mines from copper-selling agencies in the United States indicate that 3,066,600,000 pounds of copper was delivered to domestic and foreign purchasers in 1928 at an average price of 14.4 cents per pound, or 1.3 cents per pound more than the average price obtained in 1927. The average price for copper in 1928 is considerably below the average for the 20-year period ended in 1928.

Price per pound of copper, 1900-1928, in cents ⁴

1900-----	16. 6	1908-----	13. 2	1916-----	24. 6	1924-----	13. 1
1901-----	16. 7	1909-----	13. 0	1917-----	27. 3	1925-----	14. 2
1902-----	12. 2	1910-----	12. 7	1918-----	24. 7	1926-----	14. 0
1903-----	13. 7	1911-----	12. 5	1919-----	18. 6	1927-----	13. 1
1904-----	12. 8	1912-----	16. 5	1920-----	18. 4	1928-----	14. 4
1905-----	15. 6	1913-----	15. 5	1921-----	12. 9		
1906-----	19. 3	1914-----	13. 3	1922-----	13. 5		
1907-----	20. 0	1915-----	17. 5	1923-----	14. 7		

Average monthly prices at New York per pound of electrolytic copper, 1920-1928, in cents, as reported by the American Metal Market Co.

[F. o. b. refinery through August, 1927; thereafter, averages represent New York refinery equivalent]

Month	1920	1921	1922	1923	1924	1925	1926	1927	1928
January-----	19. 02	12. 85	13. 60	14. 66	12. 59	14. 79	13. 94	13. 12	13. 96
February-----	18. 61	12. 79	12. 97	15. 50	12. 85	14. 54	14. 14	12. 80	13. 97
March-----	18. 36	12. 23	12. 84	16. 96	13. 65	14. 17	13. 98	13. 21	13. 98
April-----	18. 54	12. 54	12. 71	16. 81	13. 36	13. 45	13. 81	12. 93	14. 10
May-----	18. 28	12. 83	13. 29	15. 63	12. 93	13. 50	13. 77	12. 74	14. 31
June-----	17. 97	12. 76	13. 71	14. 88	12. 49	13. 47	13. 79	12. 46	14. 62
July-----	18. 61	12. 35	13. 90	14. 59	12. 57	14. 07	14. 00	12. 63	14. 62
August-----	18. 44	11. 76	13. 96	14. 05	13. 31	14. 57	14. 26	13. 11	14. 62
September-----	18. 04	12. 10	13. 88	13. 60	13. 08	14. 46	14. 19	13. 05	14. 83
October-----	16. 30	12. 75	13. 80	12. 81	13. 04	14. 42	14. 10	13. 12	15. 31
November-----	14. 39	13. 16	13. 79	12. 89	13. 70	14. 48	13. 79	13. 45	15. 90
December-----	13. 48	13. 67	14. 22	12. 98	14. 32	13. 96	13. 44	13. 95	15. 94
Average-----	17. 50	12. 65	13. 56	14. 61	13. 16	14. 16	13. 93	13. 05	14. 68

Average monthly quoted prices at New York per pound of electrolytic copper, 1920-1928, in cents, as reported by the Engineering and Mining Journal

Month	1920	1921	1922	1923	1924	1925	1926	1927	1928
January-----	18. 918	12. 597	13. 465	14. 510	12. 401	14. 709	13. 822	12. 990	13. 854
February-----	18. 569	12. 556	12. 864	15. 355	12. 708	14. 463	13. 999	12. 682	13. 823
March-----	18. 331	11. 976	12. 567	16. 832	13. 515	14. 004	13. 859	13. 079	13. 845
April-----	18. 660	12. 438	12. 573	16. 663	13. 206	13. 252	13. 706	12. 808	13. 986
May-----	18. 484	12. 742	13. 111	15. 440	12. 772	13. 347	13. 599	12. 621	14. 203
June-----	18. 065	12. 697	13. 575	14. 663	12. 327	13. 399	13. 656	12. 370	14. 527
July-----	18. 576	12. 170	13. 654	14. 321	12. 390	13. 946	13. 924	12. 532	14. 527
August-----	18. 346	11. 634	13. 723	13. 822	13. 221	14. 490	14. 174	12. 971	14. 526
September-----	18. 144	11. 948	13. 748	13. 323	12. 917	14. 376	14. 062	12. 940	14. 724
October-----	15. 934	12. 673	13. 632	12. 574	12. 933	14. 300	13. 862	12. 958	15. 202
November-----	14. 257	13. 035	13. 598	12. 727	13. 635	14. 353	13. 576	13. 319	15. 778
December-----	13. 138	13. 555	14. 074	12. 823	14. 260	13. 866	13. 302	13. 774	15. 844
Average-----	17. 456	12. 502	13. 382	14. 421	13. 024	14. 042	13. 795	12. 920	14. 570

⁴ Weed, W. H., Copper Handbook: Vol. 11, pp. 1339, 1343, for years 1900 to 1903. U. S. Geological Survey computations for electrolytic copper since 1904. For 1916 and later years average price all marketable grades.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA¹

(MINE REPORT)

By C. N. GERRY ²

SUMMARY

In 1928 the mines of Arizona produced gold, silver, copper, lead, and zinc valued at \$114,300,381, the largest production of any State for the five metals; copper represented 92 per cent of the total value. The increase of \$15,509,424 over the 1927 output was almost entirely the result of the large increase in the output of copper, as the output of gold, lead, and zinc decreased considerably; the quantity of silver decreased slightly but the value increased. The large increase in the output of copper was the result of the increase in the market price of the metal. The average price of copper increased from 13.1 cents a pound in 1927 to 14.4 cents a pound in 1928. The Calumet & Arizona, United Verde, New Cornelia, United Verde Extension, Magma, Miami Copper, Arizona Commercial, Night Hawk Leasing, and Iron Cap mining companies paid dividends amounting to \$17,255,906. In addition, the Phelps Dodge Corporation, operating mines at Bisbee and Morenci, Ariz., and also in New Mexico and Mexico, paid \$4,000,000, and the Nevada Consolidated Copper Co., operating mines at Ray, Ariz., McGill, Nev., and Santa Rita, N. Mex., paid \$7,892,684.

The average value of the metals recovered from the ore, old tailings, slag, etc., increased from \$4.47 a ton in 1927 to \$4.93 in 1928; the average value in gold and silver decreased from 36 cents to 35 cents a ton.

The chief producing counties in 1928 in order of total value of metals recovered were Yavapai, Cochise, Gila, Pinal, Pima, and Greenlee, all of them large copper producers. Gold was recovered chiefly from Yavapai, Cochise, Pima, and Mohave Counties. The large decrease in the total output of gold was due chiefly to the decrease in the output from Mohave County. Silver came largely from Yavapai, Cochise, and Pinal Counties. Lead was recovered chiefly from Cochise, Maricopa, Santa Cruz, Gila, and Pima Counties. Nearly all the zinc came from Santa Cruz County.

During the decade from 1919 to 1928 most of the gold was recovered from copper ore and from dry and siliceous ore. In recent years gold from copper ore has been gradually increasing, whereas gold from siliceous ore has been decreasing. In 1928 gold from siliceous ore was less than one-sixth that in 1920 and gold from copper ore was more than double that in 1920. Gold was also saved from lead ore and from mixed ores; very little came from placers. Silver had its

¹ Work on manuscript completed March, 1930.

² The valuable assistance of B. N. Lowry and Paul Luff, of the Bureau of Mines, is acknowledged.

source chiefly in copper ore during the 10-year period, with smaller amounts from siliceous ore and lead ore. Silver from copper ore increased from 1921 to 1926, decreased in 1927, and increased in 1928; that from dry and siliceous ore has been decreasing, although it increased slightly in 1927 and 1928.

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Copper	Lead	Zinc	Year	Silver	Copper	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	\$0.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

Mine production of gold, silver, copper, lead, and zinc in Arizona, 1919-1928

Year	Mines producing		Ore, old tailings, etc. (short tons)	Gold		Silver	
	Lode	Placer		Fine ounces	Value	Fine ounces	Value
1919.....	324	15	13,727,403	217,997.72	\$4,506,413	5,266,605	\$5,898,598
1920.....	310	8	14,920,478	231,528.65	4,786,122	5,355,303	5,837,280
1921.....	178	37	5,455,030	141,753.41	2,930,303	2,469,394	2,469,394
1922.....	285	33	10,746,045	170,479.98	3,524,134	4,531,864	4,531,864
1923.....	317	24	17,015,178	296,109.23	6,121,121	7,343,742	6,021,868
1924.....	266	9	19,820,505	235,995.74	4,878,465	6,649,276	4,455,015
1925.....	368	18	20,927,382	201,740.92	4,170,355	7,257,868	5,036,961
1926.....	362	21	22,382,685	234,010.97	4,837,436	7,381,027	4,605,761
1927.....	293	15	21,991,874	200,494.59	4,144,591	6,847,680	3,882,635
1928.....	298	22	22,828,766	191,927.23	3,967,488	6,791,351	3,972,940

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919.....	538,100,844	\$100,086,757	10,203,078	\$540,763	1,717,000	\$125,341	\$111,157,872
1920.....	558,256,302	102,719,160	14,599,765	1,167,981	1,457,296	118,041	114,628,584
1921.....	185,034,194	23,869,411	6,541,433	294,364	-----	-----	29,563,472
1922.....	400,043,128	54,005,822	15,070,894	828,899	210,624	12,006	62,902,725
1923.....	618,928,602	90,982,504	16,291,548	1,140,408	519,103	35,299	104,301,200
1924.....	677,752,013	88,785,514	18,642,314	1,491,385	-----	-----	99,610,379
1925.....	713,355,129	101,296,428	23,876,017	2,077,213	7,332,116	557,241	113,138,198
1926.....	723,296,051	101,261,447	23,258,274	1,860,662	12,946,423	970,982	113,536,288
1927.....	682,190,547	89,366,962	19,865,961	1,251,556	2,268,960	145,213	98,790,957
1928.....	732,276,803	105,447,860	14,380,964	834,096	1,278,636	77,997	114,300,381

GOLD

In 1928 the mine production of gold in Arizona decreased 4 per cent compared with 1927. The largest decrease, that in Mohave County, was chiefly due to the decrease in the output of gold ore from the Katherine mine, 33 miles west of Kingman in the Union Pass district. There was also a large decrease in the production of gold in Gila County, as a result of the decrease in the output of gold from the Old Dominion property. Good increases in the output of gold, however, were made by the Calumet & Arizona, United Verde Extension, and the Morenci branch of the Phelps Dodge Corporation. Of the total output of gold, 7.5 per cent was recovered from ore and old tailings treated in gold and silver mills, 26 per cent was recovered from ore and old tailings concentrated, and 66 per cent was from crude ore shipped for smelting. Ores treated by amalgamation yielded gold valued at \$11,017 and ores and old tailings treated by cyanidation \$287,132. Concentrates yielded gold valued at \$1,036,285 in 1928, compared with \$1,064,843 in 1927. The chief gold-producing districts in 1928 were the Verde in Yavapai County, the Warren in Cochise County, and the Ajo in Pima County, all of which produced copper ores.

Of the mines yielding gold in Arizona in 1928 the United Verde Copper Co. reported the largest output; the Copper Queen at Bisbee was second; and the Calumet & Arizona at Bisbee, the New Cornelia at Ajo, the United Verde Extension at Jerome, the Magma at Superior, the Katherine near Kingman, the Morenci branch of the Phelps Dodge Corporation, and the Tom Reed at Oatman followed.

SILVER

The mine production of silver in Arizona in 1928 declined slightly from that of 1927 but the value increased more than 2 per cent, as the average price of silver increased from 56.7 cents an ounce in 1927 to 58.5 cents an ounce in 1928. The silver production of the State was more than 7,000,000 ounces in each of the four years, 1916, 1923, 1925, and 1926, but in 1927 the output declined to 6,847,680 ounces and in 1928 to 6,791,351 ounces. Good increases in the output of silver were made in 1928 by the Calumet & Arizona, Magma, Montana, Commonwealth, and United Verde Extension properties, but decreases were reported by the Copper Queen, Shattuck Denn, Old Dominion, Reymert, and Bunker Hill mines. The largest declines in silver output were reported in Gila and Cochise Counties and the largest gain was in Santa Cruz County. Bullion from gold and silver ores contained 20,103 ounces of silver recovered by cyanidation and 276 ounces recovered by amalgamation. Concentrates yielded nearly 28 per cent of the total output of silver and crude ore shipped to smelters nearly 72 per cent.

Of the total silver from Arizona in 1928, 76 per cent came from the ore of the United Verde, Calumet & Arizona, Magma, Copper Queen, and United Verde Extension, each of which produced more than 400,000 ounces. Other mines that yielded more than 100,000 ounces of silver each in 1928 were the New Cornelia, Bunker Hill, Shattuck Denn, Morenci branch of the Phelps Dodge Corporation, Reymert, and Old Dominion properties.

COPPER

The mine production of copper in Arizona in 1928 was 732,276,803 pounds, the largest output since the record output made in 1918, when 764,855,874 pounds was produced. From 1904 to 1928, inclusive, the State produced 5,898,521 short tons of copper, and in 1928 the output exceeded that of Utah, the State next in order, by 439,041,764 pounds. All the large copper producers in Arizona, except the Morenci branch of the Phelps Dodge Corporation, Miami, and Old Dominion, reported large increases. The Copper Queen and the United Verde each increased its output more than 18,000,000 pounds. Of the total copper produced in the State in 1928, 52 per cent was obtained from concentrates, 37 per cent from crude ore smelted, and 9 per cent from ore leached. Of the total output from crude ore smelted, Yavapai County yielded 52.6 per cent and Cochise County 38.8 per cent. The copper from ore milled came mainly from Gila, Pinal, Pima, Greenlee, and Cochise Counties. The low-grade disseminated ores in Cochise, Pima, Pinal, and Gila Counties yielded 330,732,567 pounds of copper in 1928, compared with 310,226,281 pounds in 1927. Similar low-grade copper deposits were worked in Greenlee County, so that the total production from the disseminated deposits in Arizona in 1928 was 381,524,338 pounds, compared with 363,983,681 pounds in 1927.

Eleven properties, each yielding more than 18,000,000 pounds, produced 97 per cent of the total copper from Arizona in 1928. The United Verde was first, followed by the Copper Queen, Inspiration, New Cornelia, Nevada Consolidated (Ray mines), Phelps Dodge property at Morenci, Miami, Calumet & Arizona, United Verde Extension, Magma, and Old Dominion mines. Other mines that produced more than 1,500,000 pounds of copper each were the Shattuck-Denn, Arizona Commercial, El Tiro, and Christmas.

LEAD

The mine production of lead in Arizona in 1928 was smaller than in any year since 1921; it was only a little more than half of the record output made in 1916, when 27,062,087 pounds was produced, and was nearly 28 per cent less than the 1927 output. The decrease was due chiefly to the large decrease in the output of lead from the Shattuck-Denn mine near Bisbee, Cochise County. There were also large decreases in the output of lead from the Copper Queen mine, also at Bisbee, and from the Aravaipa mine at Aravaipa, Graham County. Good increases, however, were made at the Belmont-MacNeill mine near Palo Verde, Maricopa County, and at the Montana mine near Ruby, Santa Cruz County. The Seventy-Nine mine near Hayden Junction, Gila County, made a large output of lead in 1928 after being idle for several years because of litigation.

Of the total lead produced in Arizona in 1928, nearly 43 per cent was obtained from concentrates and more than 56 per cent from crude ore smelted. Most of the lead produced from ore concentrated came from four mines—two near Bisbee, Cochise County, which produced lead ore; one near Palo Verde, Maricopa County, which produced copper-lead ore; and one near Ruby, Santa Cruz County, which produced lead-zinc ore. More than half of the lead produced

from crude ore smelted came from lead ore from three mines near Bisbee, Cochise County.

The largest producers of lead in Arizona in 1928 were the Copper Queen, Belmont-MacNeill, Shattuck Denn, Montana, and Seventy-Nine mines; these five properties yielded 72 per cent of the total lead output. Other large producers of lead were the Calumet & Arizona mine in Cochise County, the Lone Mountain mine in Pima County, and the Silver Bell mine in Pinal County.

ZINC

The mine production of zinc in Arizona in 1928 was a little more than half that of 1927. The decrease was partly due to the fact that no shipments of lead-zinc ore were made in 1928 from the Calumet & Arizona property and partly to the fact that the output of lead-zinc ore from mines near Kingman, Mohave County, was considerably less than in 1927. The production of zinc in Arizona has decreased from 12,946,423 pounds in 1926 to 1,278,636 pounds in 1928. The Montana mine near Ruby, Santa Cruz County, was the largest producer of zinc in Arizona in 1928; there were no other large producers.

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1928, by counties

County	Gold					Silver (lode and placer)	
	Lode		Placer		Total value	Fine ounces	Value
	Fine ounces	Value	Fine ounces	Value			
Cochise.....	63, 178. 09	\$1, 306, 007			\$1, 306, 007	2, 172, 954	\$1, 271, 178
Coconino.....	1. 74	36			36	56	33
Gila.....	5, 842. 44	120, 774			120, 774	235, 954	138, 033
Graham.....	6. 82	141			141	693	405
Greenlee.....	5, 981. 52	123, 649	24. 72	\$511	124, 160	134, 516	78, 692
Maricopa.....	4, 015. 56	83, 009	8. 42	174	83, 183	65, 653	38, 407
Mohave.....	14, 594. 98	301, 705	8. 37	173	301, 878	30, 233	17, 686
Pima.....	19, 022. 65	393, 233	29. 80	616	393, 849	234, 024	136, 904
Pinal.....	9, 117. 19	188, 469			188, 469	1, 133, 942	663, 356
Santa Cruz.....	906. 69	18, 743			18, 743	158, 299	92, 605
Yavapai.....	67, 759. 25	1, 400, 708	189. 24	3, 912	1, 404, 620	2, 619, 217	1, 532, 242
Yuma.....	1, 190. 70	24, 614	49. 05	1, 014	25, 628	5, 810	3, 399
Total, 1927.....	191, 617. 63	3, 961, 088	309. 60	6, 400	3, 967, 488	6, 791, 351	3, 972, 940
	200, 191. 91	4, 138, 334	302. 68	6, 257	4, 144, 591	6, 847, 680	3, 882, 635

County	Copper		Lead		Zinc		Total value
	Pound	Value	Pounds	Value	Pounds	Value	
Cochise.....	162, 262, 088	\$23, 365, 741	6, 329, 861	\$367, 132	22, 880	\$1, 396	\$26, 311, 454
Coconino.....	1, 567	226	502	29			324
Gila.....	162, 283, 851	23, 368, 875	1, 351, 800	78, 404			23, 706, 086
Graham.....	2, 829	407	214, 714	12, 454	28, 581	1, 743	15, 180
Greenlee.....	54, 054, 162	7, 783, 799					7, 986, 651
Maricopa.....	281, 787	40, 577	2, 582, 431	149, 781			311, 948
Mohave.....	37, 329	5, 375	161, 004	9, 338	150, 319	9, 169	343, 446
Pima.....	81, 836, 702	11, 784, 485	829, 671	48, 121			12, 363, 359
Pinal.....	105, 349, 386	15, 170, 312	453, 944	26, 329			16, 048, 466
Santa Cruz.....	764, 055	110, 024	2, 082, 878	120, 807	1, 055, 649	64, 395	406, 574
Yavapai.....	165, 296, 914	23, 802, 756	162, 780	9, 441	21, 207	1, 294	26, 750, 353
Yuma.....	106, 133	15, 283	211, 379	12, 260			56, 570
Total, 1927.....	732, 276, 803	105, 447, 860	14, 380, 964	834, 096	1, 278, 636	77, 997	114, 300, 381
	682, 190, 547	89, 366, 962	19, 865, 961	1, 251, 556	2, 268, 960	145, 213	98, 790, 957

Ore, old tailings, etc., sold or treated, lode mines producing, and average value of ore, etc., in gold and silver in Arizona, 1927 and 1928, by counties

County	Ore, old tailings, etc. (short tons)		Lode mines producing		Average value per ton in gold and silver	
	1927	1928	1927	1928	1927	1928
Cochise.....	2, 476, 414	2, 436, 595	40	33	\$1. 05	\$1. 06
Coconino.....	22	12	1	2	1. 55	5. 75
Gila.....	9, 798, 268	9, 616, 732	29	29	. 04	. 03
Graham.....	12, 228	995	2	3	. 56	. 55
Greenlee.....	1, 495, 473	1, 585, 466	5	4	. 12	. 13
Maricopa.....	15, 939	22, 301	11	15	6. 49	5. 44
Mohave.....	120, 262	31, 558	49	40	4. 54	10. 12
Pima.....	3, 411, 451	3, 688, 350	30	36	. 16	. 14
Pinal.....	3, 076, 609	3, 520, 671	26	26	. 26	. 24
Santa Cruz.....	6, 248	32, 885	25	35	4. 29	3. 39
Yavapai.....	1, 575, 476	1, 890, 830	61	53	1. 80	1. 55
Yuma.....	3, 484	2, 371	14	22	3. 25	11. 81
	21, 991, 874	22, 828, 766	293	298	. 36	. 35

MINING INDUSTRY

Although the recorded metal output of Arizona for 1928 disclosed decreases in the quantity of gold, silver, lead, and zinc, the total value of these metals and that of copper increased about \$15,500,000. The rise in the price of copper in 1928 stimulated copper production and the output in Arizona, the leading copper-producing State, averaged 61,000,000 pounds a month. In fact, the output approached the record copper output of 1918 and indicated that the mines were ready to respond further to the continued rise in price early in 1929; this led to the breaking, in 1929, of all past records of copper production in Arizona. General conditions for mining, especially at the copper mines, were excellent and have been described in many detailed articles, relating to the industry, published during the year in the *Engineering and Mining Journal*. Special articles dealing with the cost of mining at different plants were also issued by the mining division of the Bureau of Mines. Notable improvements continued to be made at the milling and smelting plants.

ORE CLASSIFICATION

Ore, old tailings, etc., sold or treated in Arizona, 1919-1928, with content in terms of recovered metals

DRY AND SILICEOUS ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919.....	294, 675	135, 941. 83	1, 031, 185	731, 813	45, 642	-----
1920.....	280, 701	149, 518. 03	1, 051, 982	505, 153	46, 123	-----
1921.....	233, 201	116, 457. 77	530, 349	121, 903	56, 171	-----
1922.....	246, 286	108, 415. 11	1, 012, 558	291, 677	762, 602	-----
1923.....	556, 293	184, 458. 86	1, 968, 675	5, 567, 683	40, 870	-----
1924.....	239, 755	100, 630. 06	610, 213	1, 268, 955	30, 270	-----
1925.....	124, 990	36, 963. 83	505, 727	251, 411	1, 131, 863	-----
1926.....	139, 949	50, 685. 30	460, 826	327, 205	67, 669	-----
1927.....	151, 701	30, 418. 12	461, 321	229, 548	48, 898	-----
1928.....	146, 825	22, 583. 49	486, 842	1, 457, 928	52, 311	-----

Ore, old tailings, etc., sold or treated in Arizona, 1919-1928, with content in terms of recovered metals—Continued

COPPER ORE

Year	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
1919	13,347,182	78,103.32	13,711,052	1537,201,237	179	-----
1920	14,516,580	76,402.41	13,716,246	1557,364,143	-----	-----
1921	5,181,177	21,732.17	11,241,436	1184,812,780	-----	-----
1922	10,431,729	57,745.04	12,766,277	1399,264,191	2,812	-----
1923	16,331,974	106,691.21	14,269,278	1612,303,029	7,282	-----
1924	19,460,836	128,121.07	15,101,837	1675,635,828	-----	-----
1925	20,634,428	1153,549.54	15,795,173	1711,380,756	151	-----
1926	22,031,292	167,920.23	15,984,415	1720,968,835	244	-----
1927	21,677,976	159,843.83	15,702,270	1681,158,850	674	-----
1928	22,584,270	161,071.48	15,885,625	1729,992,797	3,383	-----

LEAD ORE

1919	76,247	3,701.41	441,739	137,546	10,088,794	-----
1920	116,269	5,352.21	521,441	213,346	13,641,815	-----
1921	40,511	2,947.62	645,563	89,263	6,435,217	-----
1922	67,138	3,723.28	744,559	461,980	14,119,456	-----
1923	115,369	4,514.11	1,090,534	1,035,034	15,991,220	-----
1924	114,670	6,407.26	912,741	725,567	18,373,553	-----
1925	127,944	7,807.84	803,153	877,474	19,580,573	-----
1926	157,854	10,686.05	716,945	837,443	19,478,777	-----
1927	137,195	9,090.83	609,718	609,519	18,408,177	28,518
1928	50,651	3,399.64	263,130	457,708	9,985,203	-----

COPPER-LEAD ORE

1919	7,261	24.09	82,593	30,248	68,463	-----
1920	5,108	35.07	65,619	173,660	842,037	-----
1921	141	10.00	1,956	10,248	50,045	-----
1922	435	16.97	8,357	25,280	101,673	-----
1923	229	16.74	15,183	22,856	101,119	-----
1924	5,244	685.50	24,458	118,663	238,491	-----
1925	24,565	3,264.49	144,567	833,163	626,720	-----
1926	25,020	2,607.66	145,989	976,026	360,759	-----
1927	4,449	246.97	38,824	156,938	546,416	-----
1928	22,083	3,822.74	60,162	291,798	2,833,572	-----

ZINC ORE AND LEAD-ZINC ORE ¹

1919	2,038	-----	-----	-----	-----	1,717,000
1920	1,820	-----	-----	-----	69,790	1,457,296
1921	-----	-----	-----	-----	-----	-----
1922	457	-----	-----	-----	84,351	210,624
1923	1,313	-----	-----	-----	151,057	519,103
1924	-----	-----	-----	-----	-----	-----
1925	15,455	148.80	9,224	12,325	2,536,710	7,332,116
1926	28,570	1,772.77	72,796	186,542	3,350,825	12,946,423
1927 ²	20,553	592.16	35,504	35,692	861,796	2,240,442
1928	24,937	740.25	95,546	76,572	1,506,495	1,278,636

¹ Includes metal recovered from precipitates.

² Includes copper-lead-zinc ore in 1927, as follows: 7,481 tons, yielding 478.34 ounces of gold, 18,212 ounces of silver, 22,346 pounds of copper, 371,487 pounds of lead, and 767,893 pounds of zinc.

Ore, old tailings, etc., sold or treated in Arizona in 1928, with content in terms of recovered metals

Source	Mines producing	Ore, old tailings, etc.		Gold		Silver	
		Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore.....	74	52,089	0.23	17,844.40	9.30	30,424	0.45
Dry gold and silver ore.....	7	53,264	.23	1,366.63	.71	42,406	.62
Dry silver ore.....	29	141,472	.18	3,372.46	1.76	414,012	6.10
Copper ore.....	98	22,584,270	98.93	161,071.48	83.92	5,885,625	86.66
Lead ore.....	101	50,651	.22	3,399.64	1.77	263,130	3.87
Copper-lead ore.....	13	22,083	.10	3,822.74	1.99	60,162	.89
Lead-zinc ore.....	8	24,937	.11	740.28	.39	95,546	1.41
Total, lode mines.....	298	22,828,766	100.00	191,617.63	99.84	3,679,305	100.00
Total, placers.....	22			309.60	.16	46	
Total, 1927.....	320	22,828,766	100.00	191,927.23	100.00	3,679,351	100.00
	308	21,991,874		200,494.59		6,847,680	

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore.....	25,744		5,093	0.04		
Dry gold and silver ore.....	1,250,364	0.17	502			
Dry silver ore.....	181,820	.03	46,716	.33		
Copper ore.....	7,729,992,797	99.69	3,383	.02		
Lead ore.....	457,708	.06	9,985,203	69.43		
Copper-lead ore.....	291,798	.04	2,833,572	19.70		
Lead-zinc ore.....	76,572	.01	1,506,495	10.48	1,278,636	100.00
Total, 1927.....	7,732,276,803	100.00	14,380,964	100.00	1,278,636	100.00
	6,682,190,547		19,865,961		2,268,960	

¹ Includes 1,100 tons of old tailings cyanided and concentrated and 1,708 tons of old tailings sold to a smelter.

² Includes 4,116,029 tons of ore leached, 16 tons of slag sold to a smelter, and 410 tons of smelter cleanings.

³ Includes 217 ounces of silver recovered from precipitates.

⁴ Includes 2,500 tons of old tailings concentrated and 397 tons of slag sold to a smelter.

⁵ A mine producing more than one class of ore is counted but once in arriving at total for all classes.

⁶ Includes 100 ounces of silver recovered from precipitates.

⁷ Includes 11,509,594 pounds of copper recovered from precipitates.

⁸ Includes 4,412,437 pounds of copper recovered from precipitates.

Value of metals from ore, old tailings, etc., sold or treated in Arizona in 1928, by kinds of ore

Kind of ore	Ore, old tailings, etc. (short tons)	Gold	Silver	Copper	Lead	Zinc	Total
Dry gold ore.....	52,089	\$368,876	\$17,798	\$3,707	\$295		\$390,676
Dry gold and silver ore.....							
ore.....	53,264	28,251	24,807	180,053	29		233,140
Dry silver ore.....	41,472	69,715	242,197	26,182	2,710		340,804
Copper ore.....	22,584,270	3,329,643	13,443,091	105,118,963	196		111,891,893
Lead ore.....	50,651	70,277	153,931	65,910	579,142		869,260
Copper-lead ore.....	22,083	79,023	35,195	42,019	164,347		320,584
Lead-zinc ore.....	24,937	15,303	55,894	11,026	87,377	\$77,997	247,597
Total, 1927.....	22,828,766	3,961,088	13,972,913	105,447,860	834,096	77,997	114,293,954
	21,991,874	4,138,334	13,882,611	89,366,962	1,251,556	145,213	98,784,676

¹ Includes value of 217 ounces of silver and 11,509,594 pounds of copper recovered from precipitates.

² Includes value of 100 ounces of silver and 4,412,437 pounds of copper recovered from precipitates.

GOLD ORE

Gold ore, which represented about one-fourth of 1 per cent of the total output of ore, old tailings, etc., was reported from 74 mines in

1928. This material, the production of which decreased 57 per cent from that of 1927, yielded on the average \$7.08 in gold and 0.58 ounce of silver to the ton, with a little copper and lead, and had a value of \$7.50 in metals a ton. The decrease in gold ore in 1928 was due chiefly to the large decrease in the output of gold ore from the Katherine mine near Kingman. Mohave County, with 23 mines producing gold ore, reported the largest output; it was followed by Yavapai County, with 20 mines. The largest producers of gold ore were the Katherine mine in the Union Pass district near Kingman, the Congress mine at Congress, Yavapai County, and the Tom Reed mine at Oatman, Mohave County.

GOLD AND SILVER ORE

Seven mines in five counties reported the production of gold and silver ore. This material, the production of which was nearly five times greater than that in 1927, yielded on the average 53 cents in gold and 0.796 ounce of silver to the ton, 1.174 per cent of copper, and a little lead, and was valued at \$4.38 in metals a ton. Most of the gold and silver ore came from the Copper Queen property at Warren, Cochise County.

SILVER ORE

A total of 29 mines in 9 counties reported the output of silver ore and old tailings. This material, the output of which was more than double that of 1927, yielded on the average \$1.68 in gold and 9.98 ounces of silver to the ton, with a little copper and lead, and was valued at \$8.22 in metals a ton. The Bunker Hill property at Tombstone, Cochise County, produced one-half of the total output of silver ore and old tailings; most of the remainder came from the Reymert mine near Superior, Pinal County, and from the Commonwealth property near Pearce, Cochise County.

COPPER ORE

Of the copper ore, slag, etc., produced in 1928 at 98 mines in Arizona, 18,840,120 tons came from six low-grade disseminated deposits worked by five companies, whose mines are near Globe, Ray, Ajo, Bisbee, and Morenci. The crude copper ore mined and smelted (without concentration) amounted to 2,674,321 tons, and most of it was sulphide material. The total copper ore, etc., sold or treated in 1928 increased more than 4 per cent; it yielded on the average 15 cents in gold and 0.26 ounce of silver to the ton, 1.59 per cent of copper, and a little lead, and was valued at \$4.88 in metals a ton, compared with \$4.39 in 1927. The largest producers of copper ore were the Inspiration, Miami, New Cornelia, and Nevada Consolidated (Ray mines) properties. Most of the ore from these four properties was either milled or leached. The largest producers of copper ore for direct shipment to a smelter were the United Verde, Calumet & Arizona, Copper Queen, and United Verde Extension mines.

LEAD ORE

The output of lead ore, old tailings, etc., decreased from 137,195 tons in 1927 to 50,651 tons in 1928, due chiefly to the large decrease in the output of lead ore from the mines near Bisbee, Cochise County.

In 1928 this material yielded on the average \$1.39 in gold and 5.195 ounces of silver to the ton, 9.86 per cent of lead, and a little copper, and was valued at \$17.16 in metals a ton. More than 65 per cent of the total lead ore, old tailings, etc., came from the Copper Queen and Shattuck Denn mines near Bisbee, Cochise County; most of the remainder came from mines near Patagonia, Santa Cruz County; Tombstone, Cochise County; Hayden Junction, Gila County; and Pantano, Pima County.

COPPER-LEAD ORE

Thirteen mines in four counties made the output of 22,083 tons of copper-lead ore, a decided increase when compared with 4,449 tons in 1927. In 1928 the ore yielded on the average \$3.58 in gold and 2.724 ounces of silver to the ton, 0.66 per cent of copper, and 6.416 per cent of lead, and was valued at \$14.52 in metals a ton. Most of the output of copper-lead ore came from the Belmont-MacNeill property near Palo Verde, Maricopa County, operated by the Tonopah Belmont Development Co.

LEAD-ZINC ORE

The output of lead-zinc ore increased from 11,752 tons in 1927 to 24,937 tons in 1928. This ore, produced by eight mines in 1928, yielded on the average 61 cents in gold and 3.83 ounces of silver to the ton, 0.154 per cent of copper, 3.02 per cent of lead, and 2.564 per cent of zinc, and was valued at \$9.93 in metals a ton. Most of the lead-zinc ore came from the Montana mine near Ruby, Santa Cruz County. The mine is owned by the Eagle-Picher Lead Co.

Ore, old tailings, etc., sold or treated in Arizona in 1928, by counties, with content in terms of recovered metals

DRY GOLD ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Cochise.....	66	53.79	132	280	299	-----
Gila.....	108	77.20	209	734	-----	-----
Maricopa.....	614	254.27	224	1,956	1,069	-----
Mohave.....	29,776	14,501.46	17,661	598	50	-----
Pima.....	67	141.11	66	21	-----	-----
Pinal.....	11	14.30	29	167	-----	-----
Santa Cruz.....	21	24.47	20	10	88	-----
Yavapai.....	21,121	1,754.40	11,965	18,977	3,587	-----
Yuma.....	305	1,023.40	118	3,001	-----	-----
Total, 1927.....	52,089	17,844.40	30,424	25,744	5,093	-----
	122,153	27,032.05	58,599	85,486	9,724	-----

DRY GOLD AND SILVER ORE

Cochise.....	51,161	916.00	32,680	1,249,908	-----
Coconino.....	7	1.76	49	290	502
Graham.....	2	1.40	78	-----	-----
Mohave.....	4	2.47	52	-----	-----
Pima.....	2,090	445.00	9,547	166	-----
Total, 1927.....	53,264	1,366.63	42,406	1,250,364	502
	11,074	2,090.88	82,418	55,510	-----

Ore, old tailings, etc., sold or treated in Arizona in 1928, by counties, with content in terms of recovered metals—Continued

DRY SILVER ORE

County	Ore, old tailings, etc.	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Cochise.....	¹ 28,025	3,178.35	220,893	129,462	46,645	-----
Gila.....	9	.20	1,502	111	-----	-----
Greenlee.....	23	-----	131	1,084	-----	-----
Mohave.....	27	6.80	832	-----	-----	-----
Pima.....	35	6.66	1,414	67	71	-----
Pinal.....	² 12,819	140.97	156,020	49,281	-----	-----
Santa Cruz.....	64	2.30	5,182	759	-----	-----
Yavapai.....	270	37.18	25,332	1,056	-----	-----
Yuma.....	200	-----	2,706	-----	-----	-----
	41,472	3,372.46	414,012	181,820	46,716	-----
Total, 1927.....	18,474	1,295.19	320,304	88,552	39,174	-----

COPPER ORE

Cochise.....	2,319,286	56,427.33	³ 1,758,943	³ 160,503,841	-----	-----
Coconino.....	5	-----	7	1,277	-----	-----
Gila.....	⁴ 9,613,400	5,504.35	221,545	³ 162,248,879	-----	-----
Greenlee.....	1,585,443	5,981.49	134,380	³ 54,053,078	-----	-----
Maricopa.....	592	4.26	14,882	32,641	-----	-----
Mohave.....	723	15.55	6,233	³ 34,398	-----	-----
Pima.....	⁵ 3,683,781	18,162.53	208,489	81,806,729	3,327	-----
Pinal.....	3,506,717	8,908.53	969,817	³ 105,275,349	-----	-----
Santa Cruz.....	4,283	90.36	5,585	661,682	56	-----
Yavapai.....	⁶ 1,868,736	65,914.19	2,565,009	³ 165,272,483	-----	-----
Yuma.....	1,304	62.89	735	102,440	-----	-----
	22,584,270	161,071.48	⁷ 5,885,625	⁷ 729,992,797	3,383	-----
Total, 1927.....	21,677,976	159,843.83	⁸ 5,702,270	⁸ 681,158,850	674	-----

LEAD ORE

Cochise.....	⁹ 38,012	2,602.63	160,306	378,597	6,267,909	-----
Gila.....	3,215	260.70	12,698	34,127	1,351,800	-----
Graham.....	244	4.00	404	1,677	168,714	-----
Maricopa.....	1	.06	7	-----	487	-----
Mohave.....	393	43.67	4,269	560	148,901	-----
Pima.....	2,134	242.78	12,126	18,858	786,917	-----
Pinal.....	514	14.10	1,821	906	269,093	-----
Santa Cruz.....	¹⁰ 4,966	82.60	54,002	18,233	642,628	-----
Yavapai.....	610	44.70	15,247	4,058	137,375	-----
Yuma.....	562	104.40	2,247	602	211,379	-----
	50,651	3,399.64	263,130	457,708	9,985,203	-----
Total, 1927.....	137,195	9,090.83	609,718	609,519	18,408,177	28,518

COPPER-LEAD ORE

Maricopa.....	21,094	3,757.00	50,540	247,190	2,581,875	-----
Pima.....	243	24.56	2,375	10,861	39,356	-----
Pinal.....	610	39.30	6,252	23,683	184,851	-----
Santa Cruz.....	136	1.88	995	10,064	28,460	-----
	22,083	3,822.74	60,162	291,758	2,833,772	-----
Total, 1927.....	4,449	246.97	38,824	156,938	546,416	-----

LEAD-ZINC ORE

Cochise.....	45	-----	-----	-----	15,008	22,880
Graham.....	749	1.40	211	1,152	46,000	28,581
Mohave.....	635	25.02	1,186	1,773	12,053	150,319
Santa Cruz.....	23,415	705.08	92,515	73,307	1,411,616	1,055,649
Yavapai.....	93	8.78	1,634	340	21,818	21,207
	24,937	740.28	95,546	76,572	1,506,495	1,278,636
Total, 1927.....	11,752	103.42	12,853	6,431	475,196	1,127,255

¹ Includes 1,100 tons of old tailings cyanided and concentrated and 1,178 tons of old tailings sold to a smelter.

² Includes 530 tons of old tailings sold to a smelter.

³ Includes metal recovered from precipitates.

⁴ Includes 3,041,972 tons of ore leached.

⁵ Includes 1,074,056 tons of ore leached and 16 tons of slag sold to a smelter.

⁶ Includes 1 ton of ore leached and 410 tons of smelter cleanings.

⁷ Includes 217 ounces of silver and 11,509,594 pounds of copper recovered from precipitates.

⁸ Includes 100 ounces of silver and 4,412,437 pounds of copper recovered from precipitates.

⁹ Includes 2,500 tons of old tailings concentrated.

¹⁰ Includes 397 tons of old slag sold to a smelter.

*Lead-zinc ore and zinc concentrates (as marketed from Arizona mines and mills)
sold to smelters in 1928*

Classification	County	Quantity (dry weight)	Gross zinc	Average assay of ore or con- centrates	Recovered zinc
		<i>Short tons</i>	<i>Pounds</i>	<i>Per cent</i>	<i>Pounds</i>
Oxidized lead-zinc ore.....	Cochise.....	45	28,600	31.78	22,880
Zinc concentrates.....	Graham, Mohave, Santa Cruz, and Yavapai.	1,556	1,476,298	47.44	1,255,756
Total, 1927.....		1,601 3,745	1,504,898 2,726,106	47.00 36.40	1,278,636 2,268,960

METALLURGIC INDUSTRY

The chief methods employed in reducing Arizona ores to bullion or metals are concentration, with subsequent smelting; leaching, followed by electrolytic deposition; smelting of first-class ore; cyanidation; and amalgamation. In recent years comparatively little ore has been treated by cyanidation or by amalgamation. Considerable ore is still being treated in leaching tanks or by heap leaching, but by far the largest part of the ore is now being concentrated, especially by flotation.

Nine smelting plants within the State, all but one treating copper ore, were active throughout the year, and considerable ore from Arizona was treated at El Paso, Tex. Since the price of copper increased nearly all the large copper producers have operated their mines at capacity. The increase in the production of copper from the Copper Queen and United Verde properties was especially large. The new lead smelter of the Phelps Dodge Corporation at Douglas was active throughout the year, and regular shipments of lead bullion were made.

Sixty milling plants in Arizona were active in 1928. Thirty-nine were concentration plants, of which 9 used table and flotation devices, 20 used flotation alone, and 10 used jigs and tables without flotation cells. Eleven mills were equipped for amalgamation, 5 for cyanidation, 2 for amalgamation and concentration, and 3 for leaching. The New Cornelia leaching plant at Ajo operated regularly and treated more than 1,000,000 tons of carbonate ore by this method. At Inspiration the new 9,000-ton leaching plant treated about 3,000,000 tons of mixed oxide and sulphide ores. Heap leaching was continued at Bisbee and Jerome.

A list of the important mills in Arizona that were active in 1928 follows:

Large mills and leaching plants in Arizona active in 1928

Name of company	Mill			Material treated	Product
	Location	Kind	Daily capacity (short tons)		
Central Copper Co.-----	Dos Cabezas	Flotation....	500	Copper ore.	Copper concentrates.
Phelps Dodge Corporation	Warren	do.....	4,000	do.....	Do.
(Copper Queen branch).		do.....	150	Lead ore..	Lead concentrates.
Inspiration Copper Co.-----	Inspiration	do.....	18,000	Copper ore.	Copper concentrates.
		Leaching.....	9,000	do.....	Electrolytic copper.
Miami Copper Co.-----	Miami	Flotation.....	12,000	do.....	Copper concentrates.
Old Dominion Copper Co.-----	Globe	do.....	1,500	do.....	Do.
Phelps Dodge Corporation	Morenci	Tables-flota-	4,500	do.....	Do.
(Morenci branch).		tion.			
Tom Reed Gold Mining Co.-----	Oatman	Cyanidation..	250	Gold ore..	Gold bullion.
Katherine Gold Mining Co.-----	Katherine	do.....	250	do.....	Do.
New Cornelia Copper Co.-----	Ajo	Flotation.....	5,000	Copper ore.	Copper concentrates.
		Leaching.....	5,000	do.....	Electrolytic copper.
Nevada Consolidated Copper	Hayden	Flotation.....	12,000	do.....	Copper concentrates.
Co. (Ray mines).					
Magma Copper Co.-----	Superior	Tables-flota-	600	do.....	Do.
		tion.			
Eagle-Picher Lead Co. (Mont-	Ruby	do.....	250	Lead-zinc	Lead concentrates and
tana mine).				ore.	zinc concentrates.
United Verde Copper Co.-----	Clarkdale	Flotation.....	1,200	Copper ore.	Copper concentrates.

Concentration reduced 15,885,447 tons of ore and old tailings to 900,026 tons of concentrates; in addition, gold and silver mills produced 78 tons of lead concentrates and 68 tons of siliceous gold concentrates.

Because of the development of flotation and of the interest in its relative importance as a means of concentration, the products of mills using flotation, gravity concentration, or a combination of both processes are given separately on page 775. The Bureau of Mines has issued a report³ on flotation reagents. Attention is also called to the special articles on milling plants mentioned in the following review by counties and districts.

Of the first-class material smelted, copper ore constituted the largest part. The mines of the Verde district, Yavapai County, and those of the Warren district, Cochise County, together produced 92 per cent of the copper ore smelted. Dry and siliceous ore ranked second in quantity and was followed by lead ore.

Miscellaneous material, other than ore and old tailings milled and crude ore smelted, consisted of 2,531 tons of old tailings, slag, and smelter clean-up shipped for smelting, 4,116,029 tons of ore leached, and mine-water precipitates. This material yielded nearly 92 ounces of gold, 12,752 ounces of silver, 80,451,393 pounds of copper, and 105,688 pounds of lead, valued in all at \$11,600,492. The copper came chiefly from ore leached and the gold and silver chiefly from old tailings and smelter clean-up; all the lead came from slag.

Compared with other copper-producing States, Arizona holds an important position in leaching operations. Two plants, in Gila and Pima Counties, make fine copper after leaching copper ore in tanks followed by electrolytic deposition. At two other properties, in Cochise and Yavapai Counties, copper precipitates were shipped

³ Miller, T. H., and Kidd, R. L., Flotation Reagents, 1928; Repts. of Investigations, Serial 3004, Bureau of Mines, June, 1930, 19 pp.

from heap leaching of copper ores, and precipitates were also recovered from copper-bearing mine water.

Mine production of metals at gold and silver mills in Arizona in 1928, by counties

County	Ore and old tailings treated		Recovered in bullion			
			Amalgamation		Cyanidation	
	Ore	Old tailings	Gold	Silver	Gold	Silver
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Cochise.....	6	1,100	4.39	2	11.68	1,149
Gila.....	15	-----	12.60	3	-----	-----
Maricopa.....	515	-----	81.07	83	104.54	29
Mohave.....	29,473	-----	215.49	108	13,773.77	16,219
Pima.....	50	-----	36.23	8	-----	-----
Santa Cruz.....	20	-----	16.17	11	-----	-----
Yavapai.....	995	-----	155.56	57	-----	-----
Yuma.....	216	-----	11.44	4	-----	2,706
Total, 1927.....	31,290 104,145	1,100 515	532.95 836.08	276 746	13,889.99 22,281.76	20,103 40,694

County	Concentrates and recovered metal				
	Concen- trates pro- duced	Gold	Silver	Copper	Lead
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Cochise.....	72	31.87	5,551	-----	44,343
Maricopa.....	6	14.00	16	29	1,069
Yavapai.....	68	133.20	144	2,184	-----
Total, 1927.....	146 14	179.07 33.00	5,711 45	2,213 117	45,412 2,243

Mine production of metals from concentrating mills in Arizona in 1928, by counties

County	Ore and old tailings to concentrating mills		Concentrates and recovered metal					
			Concen- trates pro- duced	Gold	Silver	Copper	Lead	Zinc
	Ore	Old tail- ings						
	<i>Short tons</i>	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Cochise.....	1,278,900	2,500	163,567	5,241.00	157,733	47,077,910	1,494,603	-----
Gila.....	6,490,507	-----	168,442	5,292.45	197,831	107,104,970	13,127	-----
Graham.....	749	-----	107	1.40	211	1,152	46,000	28,581
Greenlee.....	1,563,706	-----	109,651	5,693.38	119,048	50,791,771	-----	-----
Maricopa.....	21,604	-----	4,036	3,757.00	65,374	271,756	2,580,875	-----
Mohave.....	1,335	-----	284	25.47	3,494	27,610	29,506	150,319
Pima.....	2,574,200	-----	105,986	18,653.48	209,288	60,076,738	21,823	-----
Pinal.....	3,463,165	-----	260,573	7,407.79	763,031	94,075,045	51,633	-----
Santa Cruz.....	27,208	-----	3,301	752.31	136,586	84,251	1,654,542	1,055,649
Yavapai.....	461,012	-----	83,911	3,104.74	226,957	23,215,445	66,673	21,207
Yuma.....	561	-----	168	22.20	1,054	8,127	137,204	-----
Total, 1927.....	15,882,947 15,101,802	2,500 17,895	900,026 917,579	49,951.22 51,478.78	1,880,607 1,828,266	382,734,775 356,334,683	6,095,986 10,523,259	1,255,756 1,187,139

Gross metal content of Arizona concentrates produced in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	539	1, 374. 49	20, 008	4, 808	3, 877	-----
Copper.....	889, 423	43, 291. 71	1, 613, 247	396, 632, 738	-----	-----
Lead.....	4, 515	1, 519. 78	177, 917	101, 556	3, 745, 900	-----
Zinc.....	1, 556	164. 91	21, 472	29, 623	166, 384	1, 476, 298
Copper-lead.....	4, 139	3, 779. 40	53, 674	334, 033	2, 784, 979	-----
	900, 172	50, 130. 29	1, 886, 318	397, 102, 758	6, 701, 140	1, 476, 298

Mine production of metals from Arizona concentrates in 1928

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Cochise.....	163, 639	5, 272. 87	163, 284	47, 077, 910	1, 538, 946	-----
Gila.....	168, 442	5, 292. 45	197, 831	107, 104, 970	13, 127	-----
Graham.....	107	1. 40	211	1, 152	46, 000	28, 581
Greenlee.....	109, 651	5, 693. 38	119, 048	50, 791, 771	-----	-----
Maricopa.....	4, 042	3, 771. 00	65, 390	271, 785	2, 581, 944	-----
Mohave.....	284	25. 47	3, 494	27, 610	29, 506	150, 319
Pima.....	105, 986	18, 653. 48	209, 288	60, 076, 738	21, 823	-----
Pinal.....	260, 573	7, 407. 79	763, 031	94, 075, 045	51, 633	-----
Santa Cruz.....	3, 301	752. 31	136, 586	84, 251	1, 654, 542	1, 055, 649
Yavapai.....	83, 979	3, 237. 94	227, 101	23, 217, 629	66, 673	21, 207
Yuma.....	168	22. 20	1, 054	8, 127	137, 204	-----
	900, 172	50, 130. 29	1, 886, 318	382, 736, 988	6, 141, 398	1, 255, 756
Total 1927.....	917, 593	51, 511. 78	1, 828, 311	356, 334, 800	10, 525, 502	1, 187, 139

BY KINDS OF CONCENTRATES

Dry and siliceous.....	539	1, 374. 49	20, 008	4, 473	3, 587	-----
Copper.....	889, 423	43, 291. 71	1, 613, 247	382, 361, 648	-----	-----
Lead.....	4, 515	1, 519. 78	177, 917	82, 171	3, 354, 666	-----
Zinc.....	1, 556	164. 91	21, 472	20, 740	141, 420	1, 255, 756
Copper-lead.....	4, 139	3, 779. 40	53, 674	267, 956	2, 641, 725	-----

Arizona ores and old tailings concentrated in 1928, by methods of concentration

Method of concentration	Ore and old tailings concentrated	Concentrates and metal content (gross and recovered)			
		Concentrates produced ¹	Gold	Silver	
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	
Flotation.....	14, 052, 777	700, 269	36, 518. 09	959, 174	
Tables and flotation.....	1, 831, 058	199, 261	13, 258. 52	917, 471	
Tables.....	1, 612	496	174. 61	3, 962	
	15, 885, 447	900, 026	49, 951. 22	1, 880, 607	

Concentrates and metal content (gross and recovered)—Continued

Method of concentration	Copper		Lead		Zinc	
	Gross	Recovered	Gross	Recovered	Gross	Recovered
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Flotation.....	316, 548, 714	306, 021, 369	4, 716, 816	4, 364, 548	234, 358	200, 107
Tables and flotation.....	80, 512, 312	76, 676, 063	1, 641, 593	1, 469, 742	1, 241, 940	1, 055, 649
Tables.....	39, 399	37, 343	292, 263	261, 696	-----	-----
	397, 100, 425	382, 734, 775	6, 650, 672	6, 095, 986	1, 476, 298	1, 255, 756

¹ Figures do not include 146 tons from ore and old tailings first treated by amalgamation or cyanidation containing 179.07 ounces of gold, 5,711 ounces of silver, 2,333 pounds of copper (2,213 pounds recovered), and 50,468 pounds of lead (45,412 pounds recovered).

Gross metal content of Arizona crude ore shipped to smelters in 1928

Class of ore	Quantity (dry weight)	Gross metal content				
		Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry and siliceous.....	87,848	6,716.29	430,960	1,862,600	5,989	-----
Copper.....	2,674,321	117,716.68	4,270,841	284,961,608	5,566	-----
Lead.....	29,842	2,496.12	163,567	515,360	8,885,317	-----
Copper-lead.....	313	43.34	6,488	29,279	214,906	-----
Lead-zinc.....	45	-----	-----	-----	21,440	28,600
	2,792,369	126,972.43	4,871,856	287,368,847	9,133,218	28,600

Mine production of metals from Arizona crude ore shipped to smelters in 1928

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Cochise.....	1,152,911	57,866.17	2,004,709	104,427,314	4,790,915	22,880
Coconino.....	12	1.76	56	1,567	502	-----
Gila.....	84,238	537.40	38,109	5,069,611	1,338,673	-----
Graham.....	246	5.40	482	1,677	168,714	-----
Greenlee.....	21,760	288.11	15,463	3,152,296	-----	-----
Maricopa.....	182	58.98	151	10,002	487	-----
Mohave.....	750	580.24	10,412	9,275	131,498	-----
Pima.....	40,028	332.93	24,711	2,935,891	807,848	-----
Pinal.....	56,976	1,708.51	364,587	11,238,709	402,311	-----
Santa Cruz.....	5,260	133.23	20,415	679,125	322,648	-----
Yavapai.....	1,428,412	64,302.65	2,390,719	141,464,949	96,107	-----
Yuma.....	1,594	1,157.05	2,042	98,006	74,175	-----
	2,792,369	126,972.43	4,871,856	269,088,422	8,133,878	22,880
Total, 1927.....	2,613,934	124,370.79	4,919,954	253,183,235	8,647,736	1,081,821

BY KINDS OF ORE

Dry and siliceous.....	87,848	6,716.29	430,960	1,450,903	3,312	-----
Copper.....	2,674,321	117,716.68	4,270,841	267,182,958	3,383	-----
Lead.....	29,842	2,496.12	163,567	430,719	7,920,328	-----
Copper-lead.....	313	43.34	6,488	23,842	191,847	-----
Lead-zinc.....	45	-----	-----	-----	15,008	22,880

REVIEW BY COUNTIES AND DISTRICTS

As the detailed review of the districts was omitted from the report for 1927, the production of the important districts for that year has been inserted in this report at the end of each district.

COCHISE COUNTY

In Cochise County the mine production of all metals except copper was less in 1928 than in 1927, and the decreases in lead and zinc were exceptionally large. The total value of the metals, however, increased \$4,540,920, because of the large increase in the output of copper. There were 33 mines producing, 8 less than in 1927. The value of gold decreased from \$1,317,258 to \$1,306,007, silver from \$1,290,790 to \$1,271,178, lead from \$762,130 to \$367,132, and zinc from \$57,537 to \$1,396. The value of copper increased from \$18,342,819 to \$23,365,741, and the total value of all metals from \$21,770,534 to \$26,311,454. The value of the metal output of Cochise County was close to that of Yavapai County, which was the largest in the State.

The yield of each metal is given in the table on page 765. Ore of smelting grade (1,152,911 tons) yielded on the average \$15.34 in metals a ton. Of the ore smelted, 1,053,397 tons was classified as copper ore, of which 101,599 tons was estimated to be oxidized ore and 951,798 tons sulphide ore. The lead ore and old tailings (38,012 tons), as well as the lead concentrates, were shipped to El Paso, Tex., and Douglas, Ariz., and yielded 2,602.63 ounces of gold, 160,306 ounces of silver, 378,597 pounds of copper, and 6,267,909 pounds of lead. First-class lead ore amounted to 22,501 tons, all but 792 tons of which was oxidized. Copper ore of milling grade yielded 161,512 tons of copper concentrates, which were shipped for smelting. Gold and silver bullion recovered from 1,100 tons of old tailings treated by cyanidation and 6 tons of ore treated by amalgamation was valued at \$1,005. No placer output was reported in 1928.

California district.—The mines in the California district were practically idle in 1928, but one lot of lead ore from the Hilltop Extension property was received at the Copper Queen lead smelter at Douglas early in the year. Ore shipped from the district is hauled to Rodeo, N. Mex., a station on the Southern Pacific Railroad.

In 1927 six lode mines in the California district produced 459 tons of ore, yielding \$97 in gold, 2,794 ounces of silver, 2,931 pounds of copper, and 144,635 pounds of lead, valued in all at \$11,177, or \$24.35 in metals a ton. The entire output was first-class silver-lead ore chiefly from the Ainsworth and Hilltop Extension properties and represented a marked decrease from that of 1926, when the Hilltop mine was a large producer of lead.

Cochise and Golden Rule districts (Johnson, Dragon).—Six lode mines in the Cochise and Golden Rule districts produced 948 tons of first-class ore, which yielded \$11 in gold, 822 ounces of silver, 64,651 pounds of copper, and 1,631 pounds of lead, valued in all at \$9,897, or \$10.44 in metals a ton. Most of the output was sulphide copper ore from the Mammoth & Republic group of the Arizona United Development Co. After being idle four years the Climax group of the Johnson Copper Development Co. was reopened. Development consisted of sinking the vertical shaft to the 350-foot level and of drifting on various levels.

In 1927 five lode mines in the Cochise and Golden Rule districts produced 855 tons of ore, which yielded \$8,217 in gold, 1,339 ounces of silver, 8,268 pounds of copper, and 89,644 pounds of lead, valued in all at \$15,707, or \$18.37 in metals a ton. Most of this output was first-class sulphide lead ore containing considerable gold from the Golden Rule mine.

Dos Cabezas and Teviston districts.—Four lode mines in the Dos Cabezas and Teviston districts produced 5,255 tons of ore, yielding \$7,737 in gold, 6,358 ounces of silver, 149,046 pounds of copper, and 89,145 pounds of lead, valued in all at \$38,089, or \$7.25 in metals a ton. The output consisted of 339 tons of first-class smelting ore, 4,910 tons of milling ore, which was reduced to 344 tons of copper concentrates, and a small test lot of gold ore, which was treated by amalgamation. The Central Copper Co. of Arizona (Inc.) operated its mine most of the year and did 11,684 feet of development; the flotation plant was run only 50 days. Most of the remainder of the output was silver-lead ore containing considerable gold from the

LeRoy Consolidated property, 1½ miles east of Dos Cabezas. One car of gold ore was shipped as a test from the Denmark claim.

In 1927 one placer and four lode mines in the Dos Cabezas and Teviston districts produced 14,677 tons of ore, \$8,024 in gold, 17,485 ounces of silver, 681,147 pounds of copper, and 245,196 pounds of lead, valued in all at \$122,616. The output was chiefly low-grade copper ore, treated by flotation, from the property of the Central Copper Co. of Arizona (Inc.).

Huachuca Mountain district.—One car of oxidized lead ore was shipped from the Panama mine of the Huachuca Queen Mining Co.

Swisshelm district (Webb, Elfrida).—The Four-Horse and Apex mines were worked by lessees who shipped nearly 300 tons of oxidized lead ore to Douglas. The property is near Elfrida and is opened by several tunnels, one of which is 700 feet long.

Tombstone district.—Seven lode mines in the Tombstone district produced 24,172 tons of ore and old tailings, which yielded \$47,471 in gold, 164,161 ounces of silver, 135,643 pounds of copper, and 247,316 pounds of lead, valued in all at \$177,382, or \$7.34 in metals a ton. The output consisted of 20,556 tons of first-class ore shipped for smelting, a small lot of ore which was concentrated, and 3,600 tons of old tailings, nearly all of which was treated by gravity concentration. Most of the ore and old tailings was mined by a group of lessees at the Bunker Hill property, which produced 19,541 tons of ore containing chiefly silver and gold and about 800 tons of first-class oxidized lead ore. The old tailings—more than 1,000 tons—were screened and the resulting fine material was run over concentration tables. Nearly 1,700 feet of development was done in drifts and raises, but the output was less than that of 1927. The Phelps Dodge Corporation, which controls the Bunker Hill Mines Co., stated that operations were not profitable and no new ore had been opened.

A few thousand tons of old tailings from the Grand Central dump were treated by flotation, and several cars of high-grade silver-lead concentrates were shipped to Douglas for smelting. Three cars of siliceous gold and silver ore were shipped from the Old Guard property. Miscellaneous shipments of silver ore and lead ore were made by various lessees at the Emerald, Contention, and other properties. The Melgren mines controls a group of 56 claims, including the North Bonanza property which formerly produced silver ore; only development was done in 1928.

In 1927 six lode mines in the Tombstone district produced 31,196 tons of ore and old tailings, which yielded \$64,757 in gold, 159,944 ounces of silver, 68,876 pounds of copper, and 900,178 pounds of lead, valued in all at \$221,179, or \$7.09 in metals a ton.

Turquoise district (Courtland, Pearce, Gleeson).—Six lode mines in the Turquoise district produced 10,622 tons of first-class ore and old tailings, which yielded \$25,821 in gold, 83,877 ounces of silver, 419,250 pounds of copper, 64,824 pounds of lead, and 22,880 pounds of zinc, valued in all at \$140,417, or \$13.22 in metals a ton. The entire output, except 1,178 tons of old tailings shipped for smelting, was first-class ore, chiefly siliceous silver ore from the Commonwealth property, shipped to Douglas. More than 1,000 tons of old tailings containing gold and silver was also shipped from the Commonwealth property. This property has been a regular producer for more than 30 years. The Costello group was worked by the Mono Leasing Co. and various

lessees, who shipped nearly 1,400 tons of first-class oxidized copper ore; one car of oxidized lead-zinc ore was shipped to an eastern zinc plant. The Great Western property at Courtland was worked by lessees, who shipped more than 800 tons of oxidized ore, chiefly copper ore. The Germania and Maid of Sunshine groups belonging to the Calumet & Arizona Mining Co. produced several hundred tons of oxidized copper ore. The Tejon mine produced about 400 tons of mixed ore, chiefly oxidized lead ore; the mine was worked the entire year, and about 1,000 feet of development was done. Two cars of siliceous silver ore and two cars of lead ore were shipped from the Mystery property near Gleeson. Development at the Zinc Basin claim was said to have opened zinc ore of good grade.

In 1927 nine lode mines in the Turquoise district produced 9,032 tons of ore and old tailings, which yielded \$16,318 in gold, 54,327 ounces of silver, 664,226 pounds of copper, 71,111 pounds of lead, and 32,000 pounds of zinc, valued in all at \$140,663, or \$15.57 in metals a ton.

Warren district (Bisbee, Lowell, Warren, Don Luis).—Seven lode mines in the Warren district produced 2,395,271 tons of ore, which yielded \$1,224,409 in gold, 1,916,287 ounces of silver, 161,492,168 pounds of copper, and 5,834,540 pounds of lead, valued in all at \$25,938,712, or \$10.83 in metals a ton. The output consisted of 1,121,297 tons of first-class smelting ore and of 1,273,974 tons of milling ore which was reduced to 163,090 tons of concentrates. The output included considerable copper and a little silver from mine-water precipitates and from heap leaching.

The Copper Queen branch of the Phelps Dodge Corporation at Bisbee was worked continuously and ranked second as a producer of copper in Arizona in 1928. There was a marked increase in the output of copper, although the output of gold and silver was less than that in 1927. According to the report of the corporation for 1928, development consisted of 51,016 feet of work, including 1,375 feet of diamond drilling. Most of the crude ore shipped for smelting was mined from the group of claims in the limestone area, but 1,363,892 tons of low-grade copper ore was mined from Sacramento Hill, 981,818 tons of which was treated at the concentrator near Warren, 151,088 tons was directly smelted, and 230,986 tons was leaching ore. Copper ore, concentrates, and precipitate, as well as custom material, were treated at the company's 2,300-ton copper smelter at Douglas. In 1927 the company constructed a 150-ton flotation plant for the treatment of low-grade lead ore and a 200-ton blast furnace for the smelting of lead ore and concentrates. The smelting unit operated continuously in 1928, but the flotation plant was worked only five months on account of the curtailed production of lead ore by custom shippers. The lead concentrator treated 13,039 tons of ore averaging 6.61 per cent of lead and made an extraction of 70.75 per cent of the gold, 70.72 per cent of the silver, and 88.67 per cent of the lead. The ratio of concentration was 7.19 tons to 1. The lead smelter at Douglas treated 48,020 tons of lead material, which produced 14,360 ounces of gold, 3,019,873 ounces of silver, 1,160,201 pounds of copper, and 14,769,966 pounds of lead. The copper concentrator treated 1,263,729 tons of ore averaging 2.10 per cent of copper, compared with 1,262,494 tons averaging 1.65 per cent of copper in 1927. As the

average grade of copper was higher in 1928, the ratio of concentration was changed from 9.21 tons to 1 in 1927 to 7.93 tons to 1 in 1928. The recovery of total copper was 91.26 per cent, compared with 87.53 per cent in 1927. The copper smelter at Douglas treated 815,469 tons of ore and concentrates, which produced 38,250 ounces of gold, 1,540,648 ounces of silver, and 152,235,873 pounds of copper. The report continues:

Ore and metals contained in output of Copper Queen mines in 1928

Kind of material	Total (dry weight)	Gold	Silver	Copper	Lead	Manganese
	<i>Short tons</i>	<i>Ounces</i>	<i>Ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Underground limestone:						
Copper ore.....	340, 586	22, 679	403, 950	31, 240, 183		
Lead ore.....	19, 580	1, 155	73, 127	184, 262	4, 277, 156	
Manganese ore.....	3, 752					3, 049, 450
Underground porphyry: Milling ore.....	280, 536	1, 136	29, 431	12, 414, 089		
Sacramento Hill.....	1, 132, 906	7, 741	177, 269	60, 165, 631		
Precipitates.....	8, 379		229	11, 566, 234		
Total.....	1, 785, 739	32, 711	684, 006	115, 570, 399	4, 277, 156	3, 049, 450

Limestone mine copper production declined considerably from 1927 figures both in tonnage and in grade. The southwest division was practically exhausted and in December several leases were granted to finish this area. Production from the Czar and the Holbrook, which are being opened up, will take the place of the Southwest, although the grade in future will be lower. Some tonnage was obtained from the Lowell division during the year, but the Sacramento division was, as usual, the heaviest producer. All lead production came from the Southwest-Czar area, no milling ore being shipped after May, after which date low-grade material was stock-piled. Manganese production was about the same as last year. A total of 33,830 feet of development work was driven during the year, compared with 27,104 feet in 1927. Plans are under way for a materially increased amount of development work to start early in 1929, which should cover within the next few years all likely ground previously unprospected. The Warren shaft was completed in July to the 2,200-foot level. Since that time pumps have been installed on that level and drifting has been started on the 900, 1,800, and 2,200 foot levels. No ore has been encountered to date. Underground leaching continued in the Holbrook area, producing slightly over a million pounds of copper, which will be materially increased in 1929. The Southeast Extension caving operations produced a somewhat higher tonnage of better grade than last year, the total copper production from this source being 12,414,089 pounds. * * *

The Don Luis precipitation plant was enlarged early in the year and after April production was materially increased. Total shipments to the smelter contained over 10,500,000 pounds of copper. The recovery was 97.11 per cent. A small plant was constructed near the Holbrook shaft and put into operation in June to treat the acid Czar water and the enriched liquors from underground leaching in the Holbrook division. * * *

The new reverberatory department operated the entire year, smelting 81.4 per cent of the tonnage treated. The old reverberatories were operated when larger production was desired, the tonnage being part hot calcines from the new plant and part raw charge. These furnaces treated 8.9 per cent of the total tonnage, while 9.7 per cent was treated in the converters. * * *

The principal improvements at the property were: The enlargement of the Don Luis precipitation plant; the construction of the Holbrook precipitation plant, additional pumping equipment at the C. & C. shaft and at the Warren shaft; purchase of storage battery locomotives for underground haulage; various changes at the Sacramento shaft to handle the increased tonnage resulting from glory hole operations; experimental flotation machines at the concentrator; and some larger matte ladles for the smelter.

In October the various mining, milling, and smelting interests of the Phelps Dodge Corporation in Arizona, New Mexico, and Mexico

were comprehensively reviewed.⁴ Articles⁵ on the lode mines and Sacramento Hill at Bisbee, the copper and lead mills near Warren, and the copper and lead smelters at Douglas have also been published. The mineralogy of the ore and the development of the use of flotation at the Copper Queen copper mill are compared with the practice at Globe, Ariz., and at Nacozari, Mex.; details are also given regarding the smelting plants at Douglas, Ariz. The equipment of the copper smelter includes 12 roasters, 2 reverberatory furnaces, 8 converters of the Great Falls type, and Cottrell treaters. The lead smelter consists of Dwight-Lloyd sintering machine, blast furnace, roaster, converter, bag house, and bullion kettles.

There was a substantial increase in the production of gold, silver, and copper from the properties worked by the Calumet & Arizona Mining Co. at Lowell, which continued to be the largest producer of silver in the district; its copper output, however, was less than half that of the Copper Queen branch of the Phelps Dodge Corporation. The chief output was sulphide copper ore containing gold and silver. The company also produced oxidized copper ore and several hundred tons of lead ore, which was shipped to El Paso, Tex. The copper ore from the various shafts of the property is not milled but is shipped directly to the 3,500-ton smelter at Douglas. The mines⁶ produced 511,095 wet tons (498,188 dry tons) of ore from the Junction No. 3 and Cole shafts on company account and by lessees. Of this ore, 508,514 tons were treated at the company's smelter at Douglas. In addition, 2,127 tons of low-grade sulphide copper ore and 454 tons of lead ore were shipped to other plants. The average grade of the ore shipped to the company's smelter was 5 per cent of copper, compared with 4.95 per cent in 1927. The property is developed extensively, and in 1928 the company did 45,771 feet of drifting, 16,031 feet of raising, and 1,200 feet of diamond drilling.

During 1928 a total of 797,341 dry tons of ore and concentrates, consisting of 496,126 tons of ore from the mines at Lowell, Ariz., 89,840 tons of ore from the Eighty-Five branch at Valedon, N. Mex., 106,832 tons of concentrates from the New Cornelia mine at Ajo, Ariz., and 104,543 tons of ore from custom shippers, was smelted at Douglas. The output of blister copper was 122,319,580 pounds (a new plant record), compared with 111,865,800 pounds in 1927.

Dividends amounting to \$4,499,299 were distributed to stockholders, making a total of \$66,517,883 paid since the organization of the company in 1903. In 1927 dividends amounting to \$3,856,542 were paid. The net income for 1928 was \$5,221,640. The report continues:

The mines have been kept in excellent physical condition. * * *

The Campbell shaft has been connected from the 1,800 level to the 2,200 level but has not yet been completed or concreted below the 1,600 level.

An electric hoist has been ordered for this shaft which will be installed during the current year. The present hoist will be removed to the Saginaw shaft which will then be sunk to the 1,800 level and connected with the Junction workings for the purpose of ventilation and exploration. * * *

Due to the peculiar formation of the district in which your main ore deposits are located, it has never been possible to estimate the probable ore or grade which the properties contain.

⁴ Engineering and Mining Journal, Phelps Dodge Enterprise: Vol. 126, Oct. 27, 1928, pp. 641-693.

⁵ Engineering and Mining Journal: Vol. 126, Oct. 27, 1928.

⁶ Calumet & Arizona Mining Co. Ann. Rept. for 1928.

It has been considered good mining practice to maintain ore "blocked out" or "in sight" sufficient to carry on normal operations for about three years and each year to carry on sufficient development work to place "in sight" a tonnage of ore equal to that which is extracted during the year. The cost of maintaining openings in ore is so high that any other policy is not economical.

At the end of the year tonnage of known ore is slightly above normal and geological conditions shown in exploratory openings justify the hope that production of copper can be continued at the present rate and will equal in tonnage the amount produced in the past 25 years. * * *

Regular development work was well distributed throughout the lower division mine area and special development work was carried on at the Cole mine. The total footage of development work of all classes for the year, exclusive of diamond drilling, was 61,803 feet. * * *

The smelter produced from ores and concentrates received from all sources 122,319,580 pounds of blister copper. This is a new plant record. Costs were reduced and recoveries have been maintained at a very satisfactory point.

The sulphuric acid plant was operated to capacity the entire year and 66,415 tons of 60° Baumé sulphuric acid were produced. This production is somewhat less than last year but was equal to demand.

The Shattuck Denn Mining Corporation operated the Shattuck and Denn mines throughout the year and made a large production of gold, silver, copper, and lead. The output of gold, silver, and lead, however, was much less than that in 1927. The most valuable output of the mines was first-class copper ore, which was shipped for smelting; about 60 per cent of it was oxidized material from the Shattuck mine. The 450-ton milling plant at Don Luis, which treated considerable carbonate lead ore in 1927 by sulphidizing and flotation, was idle in 1928, but a large quantity of oxidized silver-lead ore was shipped to the custom flotation plant of the Phelps Dodge Corporation near Lowell and to the lead smelter at Douglas. Shipments of low-grade lead ore to the Phelps Dodge concentrator were discontinued after June 1 because of the low price of lead. According to the report⁷ for 1928 the company produced from both properties 61,389 dry tons of ore, from which 2,263.89 ounces of gold, 133,602 ounces of silver, 5,149,716 pounds of copper, and 1,548,363 pounds of lead were recovered.

The Shattuck mine produced 14,164 dry tons of carbonate lead ore, of which 3,615 tons was smelted and 10,549 tons was milled. Other shipments of first-class smelting ore consisted of 26,918 tons of oxidized copper ore and 2,820 tons of siliceous gold and silver ore. In addition to this output, the Denn mine produced 17,487 tons of first-class sulphide copper ore. From the carbonate lead ore smelted 544,086 pounds of lead, 27,534 ounces of silver, 277.68 ounces of gold, and 184,855 pounds of copper were recovered. The lead ore concentrated yielded 1,004,277 pounds of lead, 27,078 ounces of silver, and 543.06 ounces of gold. The oxidized copper ore yielded 2,938,891 pounds of copper, 25,951 ounces of silver, and 344.27 ounces of gold. From the siliceous gold and silver ores smelted 632.82 ounces of gold, 23,849 ounces of silver, and 28,030 pounds of copper were recovered. The sulphide copper ore—17,487 tons—from the Denn mine yielded 1,997,940 pounds of copper, 29,190 ounces of silver, and 466.06 ounces of gold. The average price received for lead recovered from first-class lead ore and from concentrates was 6.305 cents a pound, and the net operating cost was 9.081 cents. The average price received for copper was 14.897 cents a pound, and the net operating cost was 15.843 cents.

⁷ Shattuck Denn Mining Corporation Ann. Rept. for 1928.

The gross income for 1928 was \$713,606 and the net loss, including depletion and depreciation, was \$221,325. The surplus, however, was \$3,934,302.

The Denn shaft is 2,200 feet deep, and in 1928 the company did 220 feet of shaft sinking, 3,835 feet of diamond drilling, and 4,967 feet chiefly in drifting and raising. At the Shattuck mine 6,799 feet of work was done in drifts and raises at a cost of \$53,459. As a result of this work the ore reserves (particularly of copper ore) were said to have been greatly increased. The report of the corporation says:

During the year the Denn shaft was deepened from 2,028 feet to 2,248 feet and stations cut on the 2,100 and 2,200-foot levels. The exploration and development work was continued on the 2,000-foot level, proving the new ore body on this level to be approximately 50 feet wide and 200 feet long, averaging around 7 per cent of copper with a combined gold and silver value of \$1.50 per ton. The limits of this ore above the 2,000-foot level have not yet been determined, but the tonnage is exceeding original estimates. The ore body has been partially outlined to the 2,200-foot level by diamond drilling and drifts are now being driven on the 2,100 and 2,200-foot levels to complete this development and prepare for extraction.

The mine has been equipped with a new Nordberg double drum hoist capable of a depth of 3,500 feet, with a rope speed of 1,500 feet per minute. This will allow for hoisting 750 tons of ore daily, using mine cars, and the capacity can be increased materially by use of skips. The hoist is electric driven and equipped with flywheel motor generator set and the latest automatic safety devices, and is housed in an all-steel building. An 85-foot steel headframe has been erected with steel ore bin. At the present time the ore is being dumped into the bin from cars, but provision has been made in the headframe and bin for changing to skip hoisting should it be required in the future. A forced ventilation system has been put in through the Saginaw shaft of the Calumet & Arizona Mining Co. The air is forced from the 1,000-foot level of the Saginaw shaft through the Denn workings by a system of fans, the major units of which are two multivane fans with a capacity of 36,000 feet each per minute. The total installed cost of this new equipment was approximately \$120,000.

The Night Hawk Leasing Co. continued to operate its own property as well as property leased from the Phelps Dodge Corporation south of Bisbee. The company shipped about 13,000 tons of sulphide copper ore from its own property and about 15,000 tons of similar material from leased ground. More than 2,000 feet of development was done in 1928 in drifts, raises, and winzes, and the company paid \$65,000 in dividends, making a total of \$525,000 to date.

The Wolverine & Arizona Mining Co., owning claims near Bisbee, shipped 1,752 tons of oxidized copper ore to Douglas for smelting. The mine is opened by a vertical shaft 450 feet deep; 2,600 feet of work was done in 1928.

In 1927 six lode mines in the Warren district produced 2,419,849 tons of ore, yielding \$1,219,146 in gold, 2,037,379 ounces of silver, 138,595,349 pounds of copper, 10,511,017 pounds of lead, and 867,024 pounds of zinc, valued in all at \$21,248,014, or \$8.78 in metals a ton. Copper ore came chiefly from the Copper Queen and Calumet & Arizona properties, lead ore from the Copper Queen and Shattuck Denn mines, and lead-zinc ore from the Calumet & Arizona mine.

Milling and heap leaching near Warren and smelting at Douglas in 1928 were reviewed by Robie ⁸ in September and October.

Robie, E. H., Copper Smelting at Douglas: Eng. and Min. Jour., vol. 126, Sept. 29, 1928, p. 493; in the Bisbee-Warren district: Eng. and Min. Jour., vol. 126, Oct. 6, 1928, p. 531.

COCONINO COUNTY

Francis district.—The output of the Francis district, which is reached from Anita, a station on the branch line of the Santa Fe System from Williams to Grand Canyon, was unusually small, consisting of one car of copper ore from the Emerald property and a test lot of gold and silver ore from a prospect near by.

Warm Springs district.—At the Kaibab group of the St. Anthony Copper Co. surface trenches have developed a deposit of carbonate copper ore. A sawmill and a 2-mile tram were built, as well as a small blast furnace. The automobile service station at Jacobs Lake in the Kaibab Forest was built of copper ore from this property. Shipments of ore were made to the nearest railroad at Marysvale, Utah, early in 1929.

GILA COUNTY

Operators of 29 mines in Gila County reported 9,616,732 tons of ore sold or treated in 1928, compared with 9,798,268 tons in 1927. Gold decreased from \$171,113 to \$120,774, silver from 365,633 to 235,954 fine ounces, and copper from 173,004,343 to 162,283,851 pounds, but lead increased from 475,261 to 1,351,800 pounds. No zinc was produced in 1927 or 1928. The county ranked third in the State in value of metal output. The value increased from \$23,071,937 in 1927 to \$23,706,086 in 1928, as a result of the increase in the average price of copper and the increase in the output of lead. Copper ore was treated by concentration or leaching at Globe and Miami, but the lead products and part of the copper products were shipped to smelting plants outside of the county. Of the copper ore smelted, 43,908 tons was sulphide material and 37,163 tons oxidized ore. The 84,238 tons of smelting ore shipped had an average value of \$9.98 a ton in recovered metals, and the 168,442 tons of concentrates, nearly all copper concentrates, had an average value of \$92.90 a ton.

Banner district.—Ten lode mines in the Banner district (Gila and Pinal Counties) made a total output of 41,836 tons of ore, which yielded \$8,263 in gold, 21,058 ounces of silver, 1,799,070 pounds of copper, and 979,975 pounds of lead, valued in all at \$336,487, or \$8.04 in metals a ton. Nearly all the output was first-class smelting ore from the Banner district in Gila County, and most of it was copper ore, containing gold and silver, mined by the Christmas Copper Co. The property was worked the entire year, and about 38,000 tons of sulphide copper ore was shipped to the smelter at Hayden. The mine is opened to a depth of 830 feet, and 1,659 feet of development was done in 1928. After several years of idleness due to litigation the Seventy-Nine mine, 6 miles north of Hayden in the Banner Mountains, was again operated, and more than 2,300 tons of first-class oxidized lead ore was shipped to the smelter at Douglas during the last four months of the year. The property ranked fifth as a producer of lead in Arizona in 1928. Shipments were made at an increased rate early in 1929. The Chilito mine, 4 miles northwest of Hayden, was operated by lessees from January to September, and nearly 1,400 tons of low-grade oxidized copper ore was shipped to Hayden for smelting. Two cars of siliceous gold ore were marketed from the Oro Verde claim, 7 miles north of Hayden, and one car of similar material was shipped from the Columbia property of the Dripping Springs Mines Consolidated. A car of oxidized lead ore

from the Josefita claim was smelted at Douglas, and a test lot of lead ore was shipped from the Tornado mine. One lot of oxidized lead ore from the Alvarado property, 4 miles north of Hayden Junction, in Pinal County, was produced, and a test lot of siliceous gold ore from the Empire claim, 3 miles west of Hayden Junction, was shipped to Hayden for smelting.

In 1927 five lode mines in the Banner district produced 37,194 tons of ore, which yielded \$3,598 in gold, 11,770 ounces of silver, 1,808,211 pounds of copper, and 25,255 pounds of lead, valued in all at \$248,739, or \$6.69 in metals a ton. The largest producer was the Christmas Copper Co. operating property north of Winkelman.

Globe district (Miami, Inspiration).—In 1928 15 mines in the Globe district made a total output of 9,574,474 tons of ore, which yielded \$111,592 in gold, 213,504 ounces of silver, 160,430,341 pounds of copper, and 374,078 pounds of lead, valued in all at \$23,360,157, or \$2.44 in metals a ton. Most of the ore (6,490,207 tons) was concentrated and yielded 168,343 tons of concentrates, which, with 42,295 tons of crude ore, were shipped for smelting. Nearly all the copper concentrates and first-class copper ore went to a smelting plant in the district, but all the lead ore was shipped to El Paso, Tex., or to Douglas, Ariz.

The largest output in the district was from the Inspiration mine, which produced 4,880,136 tons of copper ore. The Miami Copper Co. followed, with 4,260,599 tons. The Old Dominion and Arizona Commercial mines also produced considerable copper ore. The Iron Cap property, formerly a large producer of copper, has been closed since November, 1927, but about 14,000 tons of low-grade siliceous dump ore, containing gold, silver, and copper, was shipped to the International smelter at Miami to be used as a flux. Lessees operating the Cordova mine of the Inspiration Consolidated Copper Co. shipped about 2,000 tons of copper ore, and various lessees shipped an equal quantity from the mine dump of the Inspiration property. Lessees operated the Mallory mine of the New Dominion Copper Co. and other lead mines in the district and shipped about 600 tons of oxidized silver-lead ore. One car of first-class sulphide lead ore and two lots of concentrates were shipped from the Money Metals property at the head of Lost Gulch, and several cars of both oxidized copper ore and lead ore were marketed by lessees operating the Mercer group, 3½ miles northeast of Globe. A car of first-class sulphide copper ore was shipped from the Independence group of claims, where about 200 feet of development was done, and two small lots of unusually rich silver ore were marketed from the Silver Lake mine.

From the Inspiration property ⁹ a total of 88,123,311 pounds of copper was produced during 1928, consisting of 38,313,520 pounds from concentrating operations, 49,692,724 pounds from leaching, and 117,067 pounds from direct smelting. As a result of the increase, especially from leaching operations, the property ranked third as a producer of copper in Arizona in 1928. The ore mined and treated averaged 1.125 per cent of copper; the concentrating and smelting ores averaged 1.296 per cent of copper and the leaching ores averaged 1.022 per cent of copper. The copper produced in 1928 was recovered from the treatment of 4,880,136 tons of ore, including

⁹ Inspiration Consolidated Copper Co. Ann. Rept. for 1928.

221,158 tons of Inspiration concentrating ore, 1,410,456 tons of Live Oak concentrating ore, 200,676 tons of Keystone concentrating ore, 3,442 tons of Inspiration ore of smelting grade, 2,432 tons of Live Oak ore of smelting grade, and 3,041,972 tons of leaching ore.

The average copper content of concentrating ore from the 1,200-foot level of the Live Oak section, which constituted more than half the total concentrating ore, was 1.464 per cent, and the average copper content of leaching ores was 1.022 per cent. The smelter assay of the total concentrates produced was 36.411 per cent of copper; flotation concentrates averaged 38.86 per cent and table concentrates 4.25 per cent. The ratio of concentration was 33.78 to 1. The recovery of copper in the concentrates, calculated from assays and weights of ore and tailings, was 83.14 per cent and the recovery of copper sulphides was 94.87 per cent. The cost of fine copper produced, including depreciation but excluding depletion and Federal taxes, amounted to 10.6624 cents a pound. No dividends were paid to stockholders in 1928 but in 1927 \$886,475 was paid. During 1928, 117,182 feet of development was done, 9,219 feet of diamond drilling, and 562 feet of churn drilling, making a total of 165 miles of workings in the property. The mine and the 18,000-ton concentration-flotation plant were operated the entire year, as well as the leaching plant, which has a daily capacity of 9,000 tons. In spite of the difficulty experienced with the fine material and copper in the sulphide minerals, 80.373 per cent of the total copper was recovered. The net income for the year ending December 31, 1928, was \$3,465,539, and the surplus was \$10,586,621. The report continues:

The tonnage of concentrating ore produced from the 1,200 level of the Live Oak averaged 1.464 per cent copper and was more than half the total tonnage sent to the concentrator. While there was no improvement in the heavy ground conditions, the changes made in the mining system resulted in lowering the costs about 12 per cent and raising the grade of ore about 9 per cent over that of the preceding year. The ground in the Live Oak section, on account of extensive faulting, is much heavier than that encountered in the Inspiration section and requires unusual care in mining.

A total of 73,415 tons of low-grade material had been hauled to the heap-leaching dump at the end of 1928. Preparations for leaching this material were in progress at the end of the year.

The total amount of underground development for the year amounted to 117,182 feet, together with 9,219 feet of diamond drilling and 562 feet of churn drilling.

During the year good progress was made on preparation for mining the sulphide ore tributary to the eighth level of the Live Oak section, and undercutting operations in this area were started in November. The construction, on this level, of ore pockets and loading station was completed and the loading machinery installed. Eighth level development of leaching ore in the eastern end of the Inspiration section was started during the year. Production from this area is expected to start by the middle of 1929. A summary of the total mine openings for all sections at the end of 1928 gave 165 miles of workings after deducting 9.69 miles of workings destroyed.

The concentrator operated 354 days during the year with an average of 5.298 sections in operation. The recoveries obtained in 1928 exceeded the average of any preceding year of operation and the mill treated 1,832,290 tons of ore. * * *

During the year a total of 3,040,171 dry tons of ore was charged into the leaching tanks. This tonnage represents 352 leaching charges or an average of 8,636.8 dry tons per tank. * * *

In the latter part of the year the problem of accounting for erratic tailings became more emphasized. This condition was definitely traced to the existence of excessive amounts of minus 200-mesh material in the charge which carried comparatively large amounts of clay. Experimental work indicated that the major portion of this material could be removed by wet classification, hence

classifiers were installed and several tanks charged with ore from which the fines had been removed. This procedure resulted in much improved leaching.

Early in 1929 all tanks were charged with deslimed ore as a regular procedure, resulting in a material increase in the recovery of copper. The slimes are being impounded for future treatment. Experimental work indicates that the slimes can be treated with satisfactory results and plans are being made for a plant to treat this material. * * *

The following articles pertaining to the flotation and leaching practices at Inspiration were published during 1927 and 1928:

BOOTH, G. H. Inspiration Copper-Leaching Plant. Eng. and Min. Jour., vol. 123, June 4, 1927, p. 926.

———. Detailed Costs of Constructing and Equipping the Inspiration Copper-Leaching Plant. Eng. and Min. Jour., vol. 124, July 16, 1927, pp. 84-86.

RUGGLES, G. H., and ADAMS, H. F. Recent Flotation Practice at Inspiration, Ariz. Min. Cong. Jour., vol. 13, September, 1927, pp. 685-690.

ALDRICH, H. W. The Inspiration Leaching Plant. Min. Cong. Jour., vol. 13, December, 1927, pp. 910-913.

ROBIE, E. H. Observations on the Inspiration Leaching Plant. Eng. and Min. Jour., vol. 125, June 16, 1928, p. 971.

———. The Inspiration Concentrator. Eng. and Min. Jour., vol. 125, June 23, 1928, p. 1013.

According to the annual printed report of the Miami Copper Co., 48,259,448 pounds of refined copper were produced from 4,260,599 tons of milling ore at a cost of 11.9 cents a pound. This output of copper was 4,778,770 pounds less than in 1927, owing to the treatment of considerable ore on the border of the deposit containing oxidized copper minerals, which resulted in a poor extraction. Despite this condition, which was temporary, the property ranked seventh as a producer of copper in Arizona in 1928. The 12,000-ton flotation plant was operated at full capacity for 360 days; it treated an average of 11,835 tons of ore a day, containing on the average 0.853 per cent of copper, of which 0.657 per cent was sulphide, compared with 0.718 per cent in 1927. A description¹⁰ of the plant was published in July. The property has in reserve 95,397,981 tons of sulphide ore averaging 0.88 per cent of copper and 7,000,000 tons of mixed ore averaging 1.83 per cent of copper. Development in 1928 consisted of 52,543 feet of drifts and 32,076 feet of raises. From 4,260,599 tons of ore milled 64,853 tons of concentrates were produced, averaging 38.358 per cent of copper, or a recovery of 68.41 per cent. The ratio of concentration was 65.7 tons to 1. Dividends amounting to \$1,120,674 were paid to stockholders in 1928, making a total of \$32,943,317 paid since May 15, 1912. The profit for 1928 was \$1,842,380, and the surplus after paying dividends was \$9,694,153. The report continues:

In addition to 84,619 feet of work charged to development account, there was driven during the year 43,032 feet of drifts and raises on stoping account, making a total footage of 127,651.

During the year nine new stopes were undercut and made ready for production and five stopes were completed with results as to extraction and cost approximately the same as those reported in previous years. * * *

The cost of mining was reduced about 1 per cent compared with the previous year and remains a little higher than the average cost of mining to date, partly due to the fact that over 10 per cent more ore was undercut during the year than was drawn.

The grade of the ore was approximately the same as for the previous year, but owing to mining being conducted around the fringes of the ore body, the oxide

¹⁰ Robie, E. H., The International Smelter and the Miami Concentrator: Eng. and Min. Jour., vol. 126, July 21, 1928, p. 97.

content was considerably higher, leaving only 0.657 per cent copper in the form of sulphide. * * *

A somewhat larger tonnage was milled than during the previous year with a reduction in cost of approximately 3 cents per ton. The average grade of concentrate produced during the year was raised from 34.26 per cent in 1927 to 38.36 per cent copper, representing a ratio of concentration of 65.7 to 1. Early in the year one section of the mill was equipped experimentally with 3-stage grinding and new matless type flotation cells to serve as a pilot for complete remodeling and enlargement of the entire mill, which is now in progress.

In July a new tailings disposal system was put in operation which involves thickening and transporting the tailings a distance of 3.5 miles from the mill to a disposal site admirably suited to the purpose and capable of accommodating all probable future tonnage. * * *

New construction during the year amounted to \$865,519, chiefly for improvements at the concentrator department. * * *

The remaining items are mostly part of a \$2,000,000 construction program, which has for its objective the remodeling of equipment and enlargement of the capacity of the plant from 12,000 tons to 17,000 tons daily with improved metallurgy and costs.

The Old Dominion Co. at Globe operated its mine and 1,500-ton flotation plant the entire year and shipped copper ore and concentrates to the International plant. According to the annual report of the company for 1928, a total of 353,392 dry tons of smelting and concentrating ore was mined, averaging 2.92 per cent of copper. The refined copper produced from this ore was 17,717,267 pounds, compared with 21,570,615 pounds in 1927. The concentrates averaged 21.48 per cent of copper, and the ratio of concentration was 8.04 tons to 1. Dividends amounting to \$14,405,260 were paid to stockholders from December 15, 1905, to December 31, 1918, but no disbursements were made in 1928. The total income for the year was \$3,349,096 and the expenses amounted to \$3,171,366, leaving a net income before depletion of \$177,730. The property has been opened to a depth of 2,700 feet, and 36,804 feet of development was done in 1928. The ore consists chiefly of the sulphide copper minerals chalcopyrite, bornite, chalcocite, and pyrite; in this respect it differs from the ore at the Inspiration and Miami properties, which is predominantly chalcocite. The report continues:

The mines operated without any interruption throughout the year. The contract for smelting and refining of all material produced was renewed with the International Smelting Co., and ores and concentrates were treated at their plant at Miami. * * *

Mining costs decreased on the basis of tons of ore extracted, due to the use of cheaper mining methods. Concentrating costs also showed improvement, and the costs of power, pumping, and other departments were satisfactory. * * *

Ore produced during the year came principally from the 1,600, 1,800, and 2,000 levels at the east part of the mine, and from the 2,000 and 2,200 levels at the west. * * *

Development work in the lower levels is difficult and slow, due to a large flow of water and high temperature. * * *

During the year there was not enough new ore developed to offset ore mined, resulting in a decrease in reserves. The work was, however, more promising than that done in 1927, especially at the west end of the mine.

The Arizona Commercial Mining Co. worked its mine the entire year on a 1-shift basis and shipped sulphide copper ore to the Old Dominion flotation plant; the resulting copper concentrates were shipped with the Old Dominion product to Miami for smelting. According to the annual printed report of the company, the total output amounted to 160,948 tons of milling ore, averaging 4.48 per

cent of copper. The total production was 4,665,605 pounds of refined copper, 29,074 ounces of silver, and 793 ounces of gold. The sales of refined copper amounted to 5,612,944 pounds, which sold for an average price of 14.8 cents a pound. Expenditures for mining, treatment, and refining were \$616,065; selling, general, and administration costs (including the payment of back taxes) were \$43,357; and depreciation was \$47,430. The total dividends paid since October 31, 1916, including \$132,500 paid in 1928, amounted to \$2,345,250. The income for 1928 was \$880,463; after \$706,852 was deducted for expenses the income before depletion was \$173,611, and the surplus at the end of the year was \$882,906. Development in 1928 consisted of 2,393 feet of drifting and 721 feet of raising. The report continues:

Development work done during recent years has not added to the ore reserves to any extent and as a result the known ore reserves are very much diminished. * * * Examination proved that exploration by diamond drilling of ground below the 2,200 level had a fair chance of finding pay ore, and this diamond drilling work will be vigorously prosecuted during the current year.

The shafts are in good condition and production came from No. 1 and No. 2 shafts in about equal amounts.

The Van Dyke Copper Co., which owns claims near Miami, shipped no ore in 1928 but unwatered and retimbered the Rice shaft, erected a new headframe, purchased an electric hoist, and made preparations for shipping in 1929.

An interesting review ¹¹ of the early history of the Globe district, with reminiscences of the early work of the Old Dominion Mining Co. at Globe, appeared in April.

In 1927 eighteen lode mines in the Globe district produced 9,760,831 tons of ore, which yielded \$165,680 in gold, 351,628 ounces of silver, 171,167,225 pounds of copper, and 429,924 pounds of lead, valued in all at \$22,815,045, or \$2.34 in metals a ton. As in recent years the chief contributors were the Inspiration, Miami, Old Dominion, and Arizona Commercial mines. Details for 1927 for these mines and other large copper producers of Arizona may be found in the printed reports of the companies or in the general report on copper in Mineral Resources for 1927.

Green Valley district.—The output of the Green Valley district consisted of small samples of gold bullion from the Gold Bond and other property in the vicinity of Payson.

Pioneer district.—The Pioneer district is chiefly in Pinal County, but part of it extends into Gila County. A small lot of rich silver ore from the Pioneer mine of the White Metal Mining Co. was shipped to Hayden for smelting.

Summit district.—Lessees working on the old dumps of the Bellevue Copper Co., formerly the Gibson Consolidated Copper Co., shipped several cars of first-class smelting ore and table concentrates which contained chiefly copper. Two cars of oxidized copper ore were marketed from the Penn and Leach claims.

Young (Spring Creek) district.—The Spring Creek property near Young was worked a short time by lessees, but no ore was shipped. However, a carload of lead concentrates containing considerable gold and silver, from former operations, was smelted at El Paso, Tex.

¹¹ Walker, A. L., Early-Day Copper Mining in the Globe District of Arizona: Eng. and Min. Jour., vol. 125, Apr. 14, 1928, p. 604, and Apr. 28, 1928, p. 694.

GRAHAM COUNTY

Three lode mines in Graham County produced 995 tons of ore, which yielded metals valued at \$15,150, most of which was lead-zinc ore from the property of the Aravaipa Mining Corporation. The output represents a decrease of \$83,393 from that of 1927, due to the inactivity at the Aravaipa property.

Aravaipa district.—Several cars of crude ore and concentrates containing chiefly lead and zinc were shipped from the property of the Aravaipa Mining Corporation. The mine, however, was not worked in 1928, and the shipments probably represented a clean-up of former operations. In 1927 the flotation plant was operated the first five months of the year, and a large production of lead resulted.

Rattlesnake district.—The only shipment from the Rattlesnake district was a small sample lot of gold and silver ore from the Long Tom No. 2 claim near Klondyke.

GREENLEE COUNTY

The total value of the metal output in Greenlee County decreased from \$8,010,362 in 1927 to \$7,986,651 in 1928. The output is chiefly copper ore from the Morenci property of the Phelps Dodge Corporation. The output of copper decreased 5,705,905 pounds, and there was also a small decrease in the output of lead; the output of gold and silver, however, increased.

Copper Mountain and Greenlee districts (Morenci, Metcalf, Clifton).—The output of the Copper Mountain and Greenlee districts was chiefly copper ore from the Morenci property of the Phelps Dodge Corporation. The company continued to operate its 4,500-ton concentration-flotation plant at Morenci and its smelter at Clifton, which is equipped with reverberatory furnaces. The chief mineral in the ore is chalcocite. A total of 34,147 feet of development was done in drifts, raises, and winzes. In addition, 587 feet of diamond drilling was done, but no new ore bodies were discovered. The smelter and the mill were operated full time, and the mine was worked 311 days during the year. The concentrator treated 1,563,706 tons of ore, which yielded 107,226 tons of copper concentrates, and the smelter treated 131,430 tons of material, from which 54,089,000 pounds of copper bullion was produced. Considerably more ore was treated in 1928 than in 1927, but the production of copper bullion was 5,352,000 pounds less, chiefly because of the lower grade of the ore. The property is a large producer of copper, silver, and gold and ranked sixth as a producer of copper in the State in 1928. A small part of the ore mined—nearly 2 per cent—was first-class sulphide smelting ore, and the remainder—more than 1,500,000 tons—was treated in the milling plant. During 1928 four Marcy mills with bowl classifiers were added to the mill, replacing smaller units, and at the smelter a plant was added to refine and cast copper anodes and ingots preparatory to electrolytic refining. The report says:

The total mine production amounted to 1,550,804 dry tons. The decrease in production, due principally to a drop in grade of ore, affected costs unfavorably. The estimate of grade of ore for the year 1929 is still lower than that mined in 1928. In all 34,147 feet of drifts, raises, and winzes, 14,263 feet of which were for stope development, 17,003 feet for prospecting, and 2,881 feet for the Long-fellow drainage tunnel, were driven. * * * The main heading for opening up the new haulage level on the 1,400 level was advanced 2,400 feet. Work is

in progress to extend both the Joy service shaft and the No. 6 hoisting shaft to the 1,400 level. * * *

The grade of ore treated was lower and the ore itself was more refractory on account of an increase in the acid soluble copper content, which caused a decrease in the recovery. During the year increased grinding and classification capacity was installed on the secondary grinding mill floor. Also orders were placed for new crushing machinery to increase the capacity of the crushing plant. During the first part of the coming year larger grinding units will be installed on the primary mill floor. The above changes will increase the total concentrator capacity from 4,300 to 5,000 tons per day and permit the maintenance of normal copper production from anticipated lower copper content ore. * * *

The anode plant was completed early in the year, and practically the entire copper production was shipped as anodes during the last nine months of the year. Excellent progress was made by the smelter organization in working out methods for removing impurities in blister copper in connection with refining copper for shipment as ingots. * * *

Labor conditions were good and the average monthly turnover—3.34 per cent—was the lowest in the history of this property.

Conditions at the mine, mill, and smelting plants of the Morenci branch of the Phelps Dodge Corporation were reviewed by Robie¹² in August and October.

Two cars of oxidized copper ore were shipped from the Keating group of the Dover Copper Mining Co., 7 miles west of Morenci. In 1928 the company built 6 miles of road to the mine, erected several camp buildings, and did 1,590 feet of tunnel work. The major development at the mine has been completed, and regular mining and production can now be started. A small lot of oxidized copper ore was shipped from the Bienes & Pitts group on American Mountain near Morenci.

Mayflower district.—One car of mixed ore containing silver and copper was shipped from the Wampo & Mayflower property, 25 miles north of Duncan.

San Francisco River district.—Placer gold valued at more than \$500 was recovered from various claims on the San Francisco River in the vicinity of Clifton.

MARICOPA COUNTY

Fifteen lode mines in Maricopa County produced 22,301 tons of ore, an increase of 6,362 tons over the output in 1927. Of the total ore 21,604 tons was concentrated and yielded 4,036 tons of concentrates; these concentrates, together with the 6 tons from gold and silver mills, had a total value in metals of \$305,096. The ore treated by amalgamation or cyanidation amounted to 515 tons and yielded gold and silver valued together at \$3,903. The first-class smelting ore amounted to 182 tons and yielded metals valued at \$2,775. Placer gold, valued at \$174, was reported by two operators. The total value of the metal output increased from \$240,405 in 1927 to \$311,948 in 1928. Most of the output was copper-lead ore containing considerable gold from the Belmont-MacNeill mine of the Tonopah Belmont Development Co.

Cave Creek district.—One car of gold ore of smelting grade was shipped from the Lucky Dream mine, 14 miles north of Phoenix, and a little gold bullion was recovered from other property in the district.

¹² Robie, E. H., The Morenci Concentrator of the Phelps Dodge Corporation: Eng. and Min. Jour., vol. 126, Aug. 25, 1928, p. 290; The Phelps Dodge Enterprise: Eng. and Min. Jour., vol. 126, Oct. 27, 1928, pp. 642-693.

Gila Bend district.—The Pacific Slope Gold Mines Corporation did 250 feet of development and remodeled the 15-ton amalgamation-cyanidation plant.

Magazine district.—The output of the Magazine district consisted chiefly of silver and copper recovered from ore mined from the Red Rover property. A 40-ton mill using table concentration and flotation machines was worked for a short time, and the resulting concentrates contained about 25 per cent of copper and 300 ounces of silver to the ton. The mine is opened to a depth of 850 feet by a vertical shaft and by drifts on several levels.

San Domingo district.—The United Vanadium Corporation did a little development at the Dragoon & Domingo property and shipped a small test lot of gold ore. Two cars of copper ore from the district were shipped from Hot Springs Junction, a station on the Santa Fe System. A small quantity of placer gold was recovered from the San Domingo Wash.

Sand Tanks district (Gila Bend).—The New Maricopa Copper Co. shipped one car of oxidized ore containing about 4 per cent of copper from property 23 miles southeast of Gila Bend.

Vulture district.—One placer and five lode mines in the Vulture district produced 21,574 tons of ore, \$81,500 in gold, 50,745 ounces of silver, 247,527 pounds of copper, and 2,582,431 pounds of lead, valued in all at \$296,611. The ore had a value of \$13.75 in metals a ton. The entire output, except 469 tons of ore treated by cyanidation and a small lot of first-class smelting ore, was copper-lead material treated by flotation. For many years the output of the Vulture district was gold bullion from operations at the Vulture property, but in 1928 the chief output in gold, silver, copper, and lead resulted from concentrates made at the Belmont-MacNeill property of the Tonopah Belmont Development Co. near Palo Verde. The mine is opened to a depth of 400 feet by nearly 9,000 feet of workings; 4,171 feet of development was done in 1928, chiefly in drifting and cross-cutting.

According to the printed report of the Tonopah Belmont Development Co., the 70-ton flotation plant was operated continuously and treated 21,094 tons of ore with an average metal content of 0.281 ounce of gold and 3.693 ounces of silver per ton, 7.72 per cent of lead, and 1.62 per cent of copper. The chief minerals are galena, cerussite, malachite, chrysocolla, and chalcocite. The mill is equipped with crusher, ball mill, Dorr classifier, Callow flotation machines, thickeners, and American filter. The ratio of concentration was 5.29 tons to 1. The mill made 3,986 tons of concentrates averaging 0.943 ounce of gold and 12.68 ounces of silver to the ton, 34.08 per cent of lead, and 3.88 per cent of copper. In 1928 the gross value of the milling ore was \$472,679, or \$22.41 in metals a ton, and the net smelter returns after deduction of freight and treatment charges were \$209,436, or \$9.93 a ton. The mining cost was \$109,570, or \$5.19 a ton; the milling cost, \$74,245, or \$3.52 a ton; and development cost, \$13.35 a foot. The property not only ranked second as a producer of lead in Arizona in 1928 but also produced much gold, silver, and copper. The report says:

The policy pursued has been to do as much development work as maintenance of the property on a self-supporting basis would permit. It is well realized that ore shoots larger than those hitherto mined must be found if the operation is to be a success. Attempts to find extensions of the present ore shoots on the bottom

or fifth level have so far been unsuccessful, and further exploration of the Uncle Sam vein has failed to find any ore. The best results have been attained on and above the second level, near the junction of the MacNeill and McKinley veins. This shoot could not be found extending down to the third level. Near the end of the year a new shoot of ore was found on the 115-foot level, a new level recently established 85 feet above the second or main adit level. * * *

Development disclosed an extremely complicated system of faults between the fourth and fifth levels, which has not yet been solved. * * *

During the last eight months of the year the ore milled was almost entirely highly oxidized ore from the upper levels. This had an adverse effect upon the mill recoveries, especially in the case of copper. Oxidized copper minerals, in association with other minerals occurring in this ore, are very difficult to recover by flotation.

No extensive work was reported by the Vulture Mining & Milling Co., but several hundred tons of ore was treated by cyanidation and concentration. The property produced gold bullion and concentrates valued at more than \$10,000 in 1927; it has been one of the largest producers of gold in Arizona.

In 1927 seven lode mines in the Vulture district produced 15,124 tons of ore, which yielded \$76,385 in gold, 37,320 ounces of silver, 179,532 pounds of copper, and 1,796,974 pounds of lead, valued in all at \$234,274, or \$15.49 in metals a ton. Most of the output was lead ore of milling grade from the Belmont-MacNeill mine.

Winifred district.—The Jack White mine of the Anglesite Mining & Development Co. was not worked in 1928, but a small lot of gold bullion from former operations was marketed. The property is equipped with a 30-ton amalgamation mill.

MOHAVE COUNTY

In Mohave County 40 lode mines produced 31,558 tons of ore, a decrease of 88,704 tons from the output in 1927. The output of all metals decreased—gold from \$495,279 to \$301,878, silver from 88,683 to 30,233 fine ounces, copper from 37,943 to 37,329 pounds, lead from 758,945 to 161,004 pounds, zinc from 1,186,826 to 150,319 pounds, and the total value of metals from \$674,304 to \$343,446. The large decrease in the output of gold, silver, lead, and zinc was due to the marked decline in the output of gold ore from the Katherine mine at Katherine and of lead-zinc ore from the Banner and Bevis Divide properties north of Kingman. The ore treated by amalgamation or cyanidation, mainly the latter, amounted to 29,473 tons, which yielded \$289,184 in gold and 16,327 ounces of silver, valued together at \$298,735, or \$10.14 in metals a ton. The concentrating ores (1,335 tons) yielded 284 tons of concentrates which had a total value in metals of \$17,426, or an average of \$61.36 a ton. Crude ore shipped to smelters amounted to 750 tons and had a total value in metals of \$27,049, or an average of \$36.06 a ton. The most important producers in the county were the Katherine mine in the Union Pass district and the Tom Reed mine at Oatman.

Aubrey district.—A test lot of ore containing gold and silver was shipped from the Boulder claim, 40 miles east of Yucca.

Cedar Valley district.—The Leviathan mine, formerly a large producer, was operated six months by a lessee representing the Molybdenum Corporation of America. Several hundred tons of ore was milled in a small flotation plant, and three cars of copper concentrates were shipped to Hayden for smelting. The ore also contains

molybdenite, but the company made no statement of the separation or shipment of this material. One small lot of copper precipitates was recovered from mine waters of the Antler mine near Yucca.

Chemehuevis district.—Placer gold, valued at \$173, from a property near Yucca was recovered by dry washing; some of it was sold to the mint at San Francisco, Calif., and some was sold to individuals for jewelry.

Cottonwood district.—The Walkover property at Hackberry was operated a short time by the Calizona Mining Co. and also by El Paloma Mining Co. Two cars of rich gold ore were shipped under the former management, and a small amalgamation plant was run by the latter company.

Indian Secret district.—The White Hills Silver Mines (Inc.) did 600 feet of development to explore several veins at a depth of 1,000 feet.

Maynard district.—Two lots of gold ore from the Foot Hill mine were shipped to the Kingman sampler, and two cars of similar ore from the Fay property, 10 miles south of Kingman, were shipped to Hayden for smelting. The American Flag mine, 15 miles southeast of Kingman, was taken over by the Wright Creek Mines Co. in September, and 200 feet of development was done. Late in the year a 30-ton flotation plant was being constructed.

Minnesota district.—The Expansion property, 32 miles west of Chloride, was operated part of the year by lessees, and three cars of rich gold ore were shipped to Hayden and Superior.

Owens (McCracken and Potts Mountain) district.—Four lode mines in the Owens district produced 280 tons of ore, yielding \$135 in gold, 2,272 ounces of silver, and 117,213 pounds of lead, valued in all at \$8,262, or \$29.51 in metals a ton. Most of the output was first-class lead ore shipped from the Lead Pill property near Signal. A car of lead ore was also shipped from the Red Top property, and one small lot of gold ore from the Gold Leaf claim was marketed. The Signal Mines Co., a large producer of silver and lead from 1922 to 1925, was idle in 1927 and 1928, but one car of lead concentrates rich in silver, the result of former milling operations, was shipped to Midvale, Utah, for smelting. A 100-ton concentration-flotation plant at the mine was idle.

San Francisco district (Oatman, Gold Road, Vivian).—Eleven lode mines in the San Francisco district produced 11,817 tons of ore, which yielded \$147,389 in gold and 4,152 ounces of silver, valued together at \$149,818, or \$12.68 a ton. The entire output, except three small lots of rich gold ore that were smelted, was gold ore treated chiefly by cyanidation. The Tom Reed Gold Mines Co. ran its 250-ton cyanidation plant continuously and treated nearly 11,800 tons of gold ore from the Tom Reed mine and from several other properties in the district, including the Western Apex, Gold Road, and United American properties. Most of the output of the district was as usual from the Tom Reed mine; the output, about 5,600 ounces of gold, was virtually the same as it was in 1927 but was much less than in 1926, when the mine produced 17,650 ounces of gold.

The property ranked ninth as a producer of gold in Arizona in 1928 but no dividends were paid, although \$3,094,215 was paid in the past. Development in 1928 consisted of completing the 900-foot shaft and driving 900 feet of lateral work. The Gold Road mine, controlled by the United States Smelting, Refining & Mining Co.,

was worked by lessees; more than 1,600 tons of ore, averaging 0.40 ounce of gold to the ton, was milled in the Tom Reed custom plant. In July the Gold Road Mining Co. was organized to operate the mine, and about 600 feet of development was done in drifting, sinking, and raising. The company also started the construction of a 100-ton cyanidation plant, which was nearly completed at the end of the year. The Western Apex property was not worked on company account, but lessees shipped about 1,800 tons of gold ore to the Tom Reed custom mill. The Big Jim mine of the United Eastern Mining Co., formerly the largest producer of gold in Arizona, was idle, but lessees shipped a little gold ore from old stopes for custom milling.

The United American Mining Co. continued to develop its property but made no shipments. The shaft has reached a depth of 937 feet. Lessees shipped more than 200 tons of gold ore to the Tom Reed custom mill. At the Pioneer property no extensive development was done, but some gold ore was treated in a small amalgamation mill and a small lot of unusually rich gold ore was shipped to a smelter. Other producers of gold ore that was shipped either to the Kingman sampler or treated locally were the Orphan group, Keystone Wedge, Sunnyside, B. and M., and Gold Reef properties. Considerable development was done at the Mossback, Highland Chief, and Tom Reed Junior properties, and a 150-ton flotation plant was installed at the Century property where the United Republic Gold Mining Co. did 1,000 feet of development. This district¹³, as well as the Wallapai district, was described in April.

In 1927 eleven lode mines in the San Francisco district produced 15,028 tons of ore, which yielded \$147,599 in gold and 4,708 ounces of silver, valued together at \$150,268, or \$10 a ton. This output represented a marked decrease from that of 1926, which was valued at \$402,188, due to the depletion of ore reserves at the Tom Reed property.

Union Pass district.—The Katherine Gold Mining Co., which owns property 33 miles west of Kingman, operated its mine the entire year and ran its 250-ton cyanidation mill seven months. The property ranked seventh as a producer of gold in Arizona in 1928 and first as a producer of gold from siliceous ore. The output was considerably less than that of 1927, but it was close to the output of the entire San Francisco (Oatman) district. No mention was made of the development done in 1928 or the quantity of ore in reserve as the property was operated under new management. A short article¹⁴ published in March described conditions at the property early in the year.

Wallapai district (Cerbat, Chloride, Kingman, Mineral Park, Stockton Hill).—Fourteen lode mines in the Wallapai district produced 995 tons of ore, yielding \$4,102 in gold, 10,770 ounces of silver, 10,450 pounds of copper, 43,791 pounds of lead, and 150,319 pounds of zinc, valued in all at \$23,617, or \$23.74 in metals a ton. Of this output 320 tons was first-class shipping ore, 635 tons was concentrating ore, and 40 tons was treated by amalgamation. The output represented a marked decrease from 19,289 tons of ore and old tailings mined or treated in 1927, when the Comstock Silver, Bevis Divide, and Hidden Treasure

¹³ Robie, E. H., Revisiting Arizona Mining Camps: Eng. and Min. Jour., vol. 125, Apr. 7, 1928, p. 586.

¹⁴ Robie, E. H., Revisiting Arizona Mining Camps: Eng. and Min. Jour., vol. 125, Mar. 31, 1928, p. 550.

properties were large producers of lead-zinc ore. No milling worthy of note was done in the district in 1928; the output consisted chiefly of small lots of ore from various properties shipped for smelting or sent to the sampler at Kingman. The Charity group of the Mohave Mining & Development Co. at Mineral Park was worked by lessees from May to the end of December, and three cars of sulphide copper ore rich in silver were shipped to the Kingman sampler. About 400 feet of development was done, but the lease was given up early in 1929. The Diana property, 1 mile west of Chloride, was worked by the Arizona Magma Mining Co., and in the course of development one car of ore containing gold and silver was shipped to the sampler at Kingman.

The Big Tennessee Mines Co. worked its Schenectady mine in the Cerbat Range and shipped a car of lead-zinc ore to Tooele, Utah, for milling. Several lots of first-class sulphide lead ore containing considerable silver were shipped by lessees from the St. Louis property near Cerbat. Other properties that produced miscellaneous shipments were the Washington Extension, Samoa, Tintic, Cashier, Twentieth Century, Atlas, and many small prospects. A car of lead concentrates and several cars of zinc concentrates were shipped from the Murray plant at Kingman, where experiments have been made on the treatment of the complex ore from several mines near Chloride. At the Banner and Prince George groups the Old Colony Mines (Ltd.) did vigorous development from June to the end of December, but the mill was idle. Development was also done at the Dardanelles and Pay Roll properties. Early in 1929 a 100-ton flotation plant was being erected at the Schuylkill & Tennessee group by the Monarch Lead Co.

Weaver district.—The Dixie Queen mine, 24 miles north of Chloride, was not regularly worked, but a small quantity of gold bullion was sold to the mint at San Francisco, Calif.

PIMA COUNTY

In Pima County the mine production of all metals except copper was less in 1928 than in 1927; the decrease in lead was especially large. However, the output of ore increased from 3,411,451 to 3,688,350 tons, copper from 75,493,619 to 81,836,702 pounds, and the total value of metals from \$10,496,790 to \$12,363,359. Gold decreased from \$395,775 to \$393,849, silver from 237,258 to 234,024 fine ounces, and lead from 1,219,456 to 829,671 pounds. No zinc was produced in 1927 or 1928. The concentrating ores (2,574,200 tons) yielded 105,986 tons of concentrates, which had a total value of \$9,160,352, and were nearly all copper concentrates from Ajo. Ore of shipping grade aggregated 40,028 tons and yielded metals valued at \$490,961. Small lots of miscellaneous ore, mined by lessees and small operators from neighboring districts in Pima and Pinal Counties, were handled through the Tucson Chamber of Mines and shipped in bulk to El Paso, Tex. Amalgamation plants treated 50 tons of ore that yielded gold and silver bullion having a total value of \$754. The placer output amounted to \$616 in gold and 7 ounces of silver.

Ajo district.—The entire output of the Ajo district was that of the New Cornelia Copper Co., which operated its 5,000-ton flotation mill and 5,000-ton leaching plant throughout the year. Ore containing malachite, chalcopyrite, bornite, and chalcocite is mined from an

open pit by steam shovels. The output of copper was nearly 7 per cent more than in 1927, and the property ranked fourth as a producer of copper and gold in Arizona in 1928. According to the printed report of the company, the output of the property in 1928 was 77,995,281 pounds of fine copper, 171,943 ounces of silver, and 16,378.82 ounces of gold. The ore concentrated amounted to 2,571,918 dry tons, averaging 1.345 per cent of copper (1.24 per cent sulphide and 0.105 per cent oxide of copper). Of the total ore mined 1,074,056 tons was carbonate ore averaging 1.105 per cent of copper, which was leached. The soluble copper in the carbonate ore averaged 1.023 per cent and the insoluble copper 0.082 per cent. In addition to the concentrating and leaching ores, 55 tons of ore containing 32.59 per cent of copper was shipped to the smelter at Douglas. Income from the sale of metals amounted to \$12,698,248 and other income was \$136,650, making a total income for the year of \$12,834,898. After various expenses of \$7,375,768 and \$450,934 for depreciation were deducted, the net income was \$5,008,196. Dividends paid to stockholders in 1928 amounted to \$3,600,000, making a total since 1918 of \$17,730,000. There was no great change in the quantity of ore treated in the leaching plant, but there was an increase in the quantity of ore milled and in the quantity of copper recovered from sulphide ore treated by flotation. The report says:

Through mining operations 5,484,344 wet tons of ore and waste were mined and delivered to the concentrator, leaching plant, smelter, and low-grade ore dumps. * * *

Work on the new approach to the pit started in November, 1927, and is about 71 per cent complete. The tonnage removed from the approach area was greater than estimated on account of enlarging the approach to remove additional ore encountered.

A No. 7 Symons cone crusher was installed in April in the fine crushing plant to replace the No. 8 gyratory and horizontal Symons. The test was successful and three additional crushers will be installed.

The tests which were conducted in the concentrator with rod mills extended from 12 feet to 15 feet also proved successful in treating larger tonnages and all mills in the plant will be extended to 15 feet in length. * * *

The increase in tonnage treated at the concentrating plant was partly due to more fines in the ore delivered from the mine and installation of the Symons cone crusher in the fine crushing plant, the product of which was partly screened, giving a finer product to the rod mills, and additional tonnages obtained from lengthening two rod mills on unit No. 4 from 12 to 15 feet.

An article ¹⁵ describing the open pit at Ajo and the leaching and milling plants, with a flow sheet of the mill, appeared in October.

Arivaca district.—Several small lots of lead ore and concentrates containing considerable gold were shipped from the Rosebud property, and a test lot of silver-lead ore was shipped from the Bogan prospect near Arivaca.

Baboquivari district.—Four lode mines in the Baboquivari district produced 2,144 tons of ore, which yielded \$9,962 in gold, 9,705 ounces of silver, 474 pounds of copper, and 294 pounds of lead, valued in all at \$15,724, or \$7.33 in metals a ton. Virtually all the output was ore of milling grade containing gold and silver from the Chance (Allison) property, 72 miles southwest of Tucson, worked by the Tom Reed Gold Mines Co. The property is opened by a 380-foot crosscut tunnel and an inclined shaft 525 feet deep; 380 feet of drifting, cross-cutting, and raising was done in 1928. The gold and silver are

¹⁵ Robie, E. H., At the New Cornelia: Eng. and Min. Jour., vol. 126, Oct. 20, 1928, p. 605.

associated with the manganese minerals, psilomelane and manganite. The 25-ton flotation mill was idle most of the year as treatment of the low-grade ore by sodium sulphide in the presence of lime, xanthate, and pine oil was said to have been unsuccessful on account of the high manganese content. Small test lots of ore from various prospects constituted the remainder of the district output.

Cababi district (Comobabi).—Small lots of ore were shipped through the Tucson Chamber of Mines from various prospects in the Cababi district, and one car of copper-lead ore containing gold and silver was marketed from the Little Mary mine of the Como Pima Mining Corporation.

Cerro Colorado district.—The output of the Cerro Colorado district consisted of 35 tons of ore, chiefly siliceous silver ore from the Mary E. mine. The Silver Queen property produced a small test lot of oxidized lead ore.

Empire district.—Six lode mines in the Empire district produced 1,435 tons of ore, which yielded \$1,662 in gold, 5,770 ounces of silver, 14,825 pounds of copper, and 645,641 pounds of lead, valued in all at \$44,619, or \$31.09 in metals a ton. The entire output was oxidized lead ore of smelting grade, chiefly from the Lone Mountain, Verde Queen, and Gopher properties. Shipments of lead ore were also made from the Lead Carbonate, Prince, and Comstock claims. The Calumet & Arizona Mining Co. worked the Verde Queen group under option and did about 2,500 feet of drifting, 125 feet of sinking, and 240 feet of upraising, but the option was surrendered late in 1928 after several hundred tons of ore had been shipped.

In 1927 four lode mines in the Empire district produced 2,366 tons of ore and old tailings, which yielded \$2,226 in gold, 10,948 ounces of silver, 15,680 pounds of copper, and 1,168,000 pounds of lead, valued in all at \$84,071, or \$35.53 in metals a ton.

Greaterville district.—Two placers and seven lodes mines in the Greaterville district produced 531 tons of ore, \$3,281 in gold, 3,541 ounces of silver, 998 pounds of copper, and 87,846 pounds of lead, valued in all at \$10,591. The ore had an average value of \$18.78 in metals a ton. The entire output of ore was first-class smelting material, chiefly from the Anderson and Reese groups in the foothills on the east side of the Santa Rita Mountains. From January until August these properties were worked by the Phelps Dodge Corporation, and several hundred tons of sulphide silver-lead ore was shipped to the Copper Queen lead plant at Douglas. Two cars of similar ore were shipped from this group by the Snyder Mining Co. Miscellaneous shipments included small lots of ore from the Golden Gate, Silver Glance, and St. Louis properties and several test lots from various prospects. Placer gold in small lots was recovered in the vicinity of Greaterville and shipped to buyers in Tucson.

In 1927 five lode mines and one placer in the Greaterville district produced 85 tons of ore, \$2,445 in gold, 1,414 ounces of silver, 633 pounds of copper, and 30,675 pounds of lead, valued in all at \$5,263.

Helvetia district.—The output of ore reported to have been produced in the Helvetia district was valued at \$3,042. Copper ore, lead ore, and molybdenum ore were treated at the custom mill of the Minerals & Metals Corporation near Sahuarita. A 40-ton mill equipped with crusher, Marcy ball mill, Dorr classifier, four K. & K. flotation machines, and settling tanks was completed and operated

on ore from Mexico and from several camps in Pima and Santa Cruz Counties.

In 1927 four lode mines in the Helvetia district produced 116 tons ore, which yielded \$136 in gold, 73 ounces of silver, 15,332 pounds of copper, and 2,761 pounds of lead, valued in all at \$2,359, or \$20.34 in metals a ton.

Pima district (Olive, San Xavier, Helmet Peak, Twin Buttes).—Three lode mines in the Pima district produced 90 tons of ore, which yielded \$367 in gold, 1,252 ounces of silver, 4,434 pounds of copper, and 29,743 pounds of lead, valued in all at \$3,462, or \$38.47 in metals a ton. The output consisted of small test lots of copper-lead ore from prospects in the district and one car of lead ore and a small quantity of copper ore from the Helmet Peak property, 10 miles west of Sahuarita, a station on the Southern Pacific Railroad. The company, however, did no regular mining, as it was engaged in development—shaft sinking, drifting, and crosscutting, approximating 2,000 feet. The decrease in the output of the Pima district has been unusually rapid. The value of the district production decreased from \$370,746 in 1925 to \$175,124 in 1926 and to \$6,933 in 1927. The Queen mine of the Midland Copper Co. was a large producer of silver and copper from 1923 to 1926, but the property was abandoned in October, 1926, as no new ore was found.

Quijotoa district.—Two small sample lots of silver ore and lead ore rich in silver were shipped from claims in the Quijotoa district, including the Ballas mine.

Santa Rosa district.—Three small sample lots of sulphide copper ore from the La Fortuna mine, 45 miles south of Casa Grande, were shipped for smelting.

Sheridan district.—The Montizona Copper Co., owning property 40 miles south of Casa Grande, did more than 1,000 feet of development in drifting and shaft sinking as well as 2,500 feet of diamond drilling. A small car of sulphide copper ore was shipped for smelting through the Tucson Chamber of Mines.

Silver Bell district.—Three lode mines in the Silver Bell district produced 37,741 tons of ore and slag, which yielded \$27 in gold, 9,798 ounces of silver, 2,856,393 pounds of copper, and 23,398 pounds of lead, valued in all at \$418,437, or \$11.09 in metals a ton. The entire output, except a small car of slag, was first-class smelting material. The largest part of the production was copper ore from the El Tiro mine of the American Smelting & Refining Co. at Silver Bell. The mine also produced a little copper-lead ore. The smelter at Hayden recovered nearly 2,500,000 pounds of copper, which represents an increase from the output of 1927. The American Smelting & Refining Co. also operated the Imperial mine at Silver Bell and produced about 6,000 tons of ore, chiefly valuable for its copper and silver content. The remainder of the district output consisted of 271 tons of oxidized copper ore and copper slag from the Atlas property.

In 1927 two lode mines in the Silver Bell district produced 27,331 tons of ore, which yielded 4,911 ounces of silver and 2,441,512 pounds of copper, valued together at \$322, 623, or \$11.80 in metals a ton.

PINAL COUNTY

In Pinal County 26 mines or dumps produced 3,520,671 tons of ore and old tailings, an increase of 444,062 tons. The gold increased

from \$182,678 to \$188,469, silver from 1,064,331 to 1,133,942 fine ounces, and copper from 91,258,140 to 105,349,386 pounds, but lead decreased from 1,084,851 to 453,944 pounds. The total value of metals increased from \$12,809,316 to \$16,048,466. Nearly all the ore, or 3,463,165 tons, was of concentrating grade and yielded 260,573 tons of concentrates, chiefly copper concentrates. First-class ore (56,976 tons) and old tailings (530 tons) were smelted. Most of the ore, whether of milling or smelting grade, came from the mines at Ray.

Banner district.—A small part of the Banner district extends from Gila County into Pinal County, and the output of the entire district is given under Gila County. One car of lead ore was shipped from the Alvarado property and one lot of siliceous gold ore from the Empire mine, both in Pinal County.

Bunker Hill district (Copper Creek).—Four lode mines in the Bunker Hill district produced 625 tons of ore, which yielded \$604 in gold, 6,786 ounces of silver, 28,237 pounds of copper, and 182,655 pounds of lead, valued in all at \$19,234, or \$30.77 in metals a ton. The output consisted of 175 tons of first-class smelting ore and 450 tons of ore that was concentrated. Several cars of copper-lead ore and concentrates and a small quantity of copper ore were shipped from the Bunker Hill property, owned by the Bunker Hill Copper Co. This property, which is equipped with a small flotation plant, was operated only a short time by various lessees, including the Bunker Hill Arizona Mining Co. Three cars of sulphide copper-lead ore containing silver were shipped from the Thornwood (Blue Bird) property, which was operated after August 1 by the Fields Mining Corporation. The mine was equipped with a compressor, generator, Diesel engine, and a new hoist; 300 feet of drifting was done in 1928. Small lots of copper ore containing considerable silver were shipped from the Las Pimas and Galesburg properties.

In 1927 three lode mines in the Bunker Hill district produced 567 tons of ore (chiefly from the Thornwood property), which yielded \$662 in gold, 19,989 ounces of silver, 34,515 pounds of copper, and 491,288 pounds of lead, valued in all at \$47,468, or \$83.72 in metals a ton. The value in 1926 was \$84,803.

Casa Grande district.—The Silver Reef property was operated part of the year by a lessee and part by the Arizona Leasing & Development Co. Nearly 1,000 tons of siliceous silver ore was shipped to the smelter at Hayden. Two small lots of lead ore and concentrates, the result of former operations, were shipped from the Orizaba group.

Mineral Creek district (Ray, Kelvin).—Four lode mines in the Mineral Creek district produced 3,243,289 tons of ore, which yielded \$22,604 in gold, 69,424 ounces of silver, and 68,660,825 pounds of copper, valued in all at \$9,950,376, or \$3.07 in metals a ton. In the value of metal output the Mineral Creek district was exceeded by only four other districts in the State. The output consisted of 8,689 tons of first-class ore, a little copper from mine-water precipitates, and 3,234,600 tons of mill ore which was reduced to 173,833 tons of concentrates. As in past years, most of the output was from the Ray mines, worked by the Nevada Consolidated Copper Co. There was an increase of about 7 per cent in the copper recovered in 1928 as well as an increase in the ore milled, but there was a decrease in the quantity of concentrates produced and a decrease in the output

of gold and silver. Both the mine and mill were operated the entire year, and the 12,000-ton concentrator was operated as an all-flotation plant. The property produced 3,243,139 tons of ore, of which 3,234,600 tons was treated at the Hayden mill, and 8,539 tons of ore, averaging nearly 2 per cent of copper, was shipped to the smelter for converter lining. The mining cost, excluding depreciation and taxes but including all other overhead expenses, was 68.83 cents a ton, compared with 76.96 cents a ton in 1927.

The flotation plant at Hayden treated on the average 8,862 tons of copper ore daily, or a total of 3,234,600 dry tons for the year. The mill ore yielded 173,833 dry tons of concentrates averaging 20.246 per cent of copper. The milling cost, excluding depreciation and all taxes but including all other expenses, as well as the cost of coarse crushing which is done at the mine, was 39.9 cents a ton, compared with 46.9 cents a ton in 1927. The gross copper contained in the concentrates was 70,387,501 pounds, compared with 65,579,968 for 1927; other crude ore, with precipitates, shipped to the smelter contained 316,955 pounds of copper. The net production for the year from all sources, after smelter deduction was allowed, was estimated to be 68,616,451 pounds, compared with 62,860,424 pounds for 1927. The property ranked fifth as a producer of copper in Arizona in 1928 and was a large producer of gold and silver. The mine is developed by vertical shafts and drifts; 33,676 feet of work was done in 1928. The report continues:

At Ray mines development on the fourth and final level of the No. 2 main hoisting shaft was actively continued throughout the year. No considerable tonnage of ore was hoisted from this level except that produced from the development and preparations of the stoping blocks, as production requirements were supplied from mining operations on the upper levels. Ore production from the fourth level will, however, be commenced early in the year 1929 and be continuous thereafter. All the development work done on this and the upper levels in the territory tributary to No. 2 shaft during the year for the purpose of delimiting the mining blocks prior to actual extraction of ore fully confirms the information furnished by previous churn drilling as to the extent and value of the ore body in the various areas. The application of the improved and lower cost methods of mining was extended wherever practical during the year, and the operation of the revised system found to be satisfactory in every respect. Besides making possible an increased output from No. 2 shaft, this also permitted production to be concentrated into more limited areas than had heretofore been possible, which improved underground conditions materially, minimized the number of active blocks required, and rendered it unnecessary to secure any output from the fourth level. The application of this system has resulted in a material decrease in the cost of mining, and has also demonstrated that it can be used successfully in practically any class of ground except that which is unusually weak and friable. Approximately 75 per cent of the total tonnage produced at No. 2 shaft during the year was mined by the improved method. No work was carried on at shafts Nos. 1 and 3 during the year except that required for maintenance. Since the end of the year mining operations have been again commenced at No. 1 shaft and sufficient production will be secured from this source to increase the total production of the mine to the full capacity of the Hayden concentrator after its eighth section is placed in commission. * * *

At Ray mines no alterations of major importance were made to the Hayden concentrator during the year, although very material reduction in the cost of milling was effected through minor revisions in the fine grinding circuit and alterations in the flotation flow sheet, which were accomplished without the installation of any additional equipment and at small cost. At the present time only seven sections of the Hayden concentrator are in commission, and toward the end of the year orders were placed for the equipment necessary to complete the eighth section, which will be ready for operation in the early summer of the current year. When the eighth section is completed the Hayden concentrator will have a capacity of 12,000 tons a day.

An article¹⁶ on the Ray mill at Hayden was published in July.

Several cars of oxidized copper ore were shipped from various prospects in the district, including the Indian Springs group which adjoins the Ray mines on the east.

In 1927 two lode mines in the Mineral Creek district produced 2,842,369 tons of ore, which yielded \$23,518 in gold, 81,228 ounces of silver, 62,860,468 pounds of copper, and 13,196 pounds of lead, valued in all at \$8,305,126, or \$2.92 in metals a ton. The Ray mines was the chief producer in 1927 as it has been in the last decade.

Old Hat district.—A small test lot of silver-lead ore was shipped from the Catalina prospect near Oracle. About 500 feet of development was done at the Aetna property near Mammoth.

Pioneer district (Superior).—Ten lode mines in the Pioneer district of Gila and Pinal Counties produced 275,637 tons of ore and old tailings, which yielded \$164,417 in gold, 1,043,370 ounces of silver, 36,654,564 pounds of copper, and 251,116 pounds of lead, valued in all at \$6,067,611, or \$22.01 in metals a ton. The output consisted of 228,066 tons of ore of milling grade, which was reduced to 86,619 tons of concentrates, 47,041 tons of first-class ore (chiefly copper ore), and 530 tons of old tailings sold to a smelter. The largest producer in the district in 1928, as well as in the past decade, was the Magma Copper Co., which operated its mine, mill, and smelter at Superior the entire year. There was an increase of about 35 per cent in the output of copper and a large increase in the output of gold and silver. The mine ranked third as a producer of silver in Arizona in 1928, sixth as a producer of gold, and tenth as a producer of copper. First-class ore is directly smelted, but most of the output was treated in the 600-ton mill equipped with concentration tables and flotation machines. The milling ore averaged 6.52 per cent of copper, chiefly in the form of chalcopyrite and bornite, and the average extraction was 98.38 per cent. Concentrates, crude ore, and a little custom ore were smelted in the company's 450-ton copper smelter at Superior. Copper bullion was shipped East for refining.

Conditions at the mine, mill, and smelting plant were reviewed by Robie¹⁷ in June. According to the annual printed report of the company, the Magma mine produced 263,094 tons of ore containing an average of 7.19 per cent of copper, 3.42 ounces of silver, and 0.034 ounce of gold to the ton. Lessees mined 1,931 tons of oxidized ore from above the 650-foot level; the ore assayed 8.91 per cent of copper, 7.18 ounces of silver, and 0.046 ounce of gold to the ton. Custom ores and concentrates purchased from various sources amounted to 18,017 tons. The total smelter output, chiefly from Magma ore and concentrates, after deduction of all losses, including refining, was 36,458,129 pounds of copper, 1,110,367 ounces of silver, and 11,779.27 ounces of gold, of which 1,229,319 pounds of copper, 193,319 ounces of silver, and 3,114.56 ounces of gold were produced from ores purchased. The average net cost of producing copper, after deduction of the value of gold and silver, was 9.227 cents a pound, as compared with 9.972 cents a pound in 1927. The cost does not include any allowance

¹⁶ Robie, E. H., Impressions of the Ray Copper Concentrator: Eng. and Min. Jour., vol. 126, July 28, 1928, p. 133.

¹⁷ Robie, E. H., Mining, Milling, and Smelting at Superior, Ariz.: Eng. and Min. Jour., vol. 125, June 9, 1928, p. 932.

for depletion or Federal taxes but includes State and county taxes, amounting to 0.83 cent a pound, depreciation and all other fixed and general expenses. The average net selling price received for copper in excess of all commissions and delivery charges was 14.7913 cents a pound. Development in 1928 consisted of 3,431 feet of drifting, 3,201 feet of raising, 4,414 feet of crosscutting, and 389 feet of shaft work; the total development to date was reported as 141,170 feet.

Dividends paid to stockholders by the Magma Copper Co. from its organization to January 15, 1929, amounted to \$6,397,782, of which four dividends totaling \$1,224,465 were paid in 1928; a dividend of \$408,155 was declared payable January 15, 1929. The dividend rate was increased in January, 1929, from \$0.75 to \$1 a share. Income from the sales of copper amounted to \$4,692,720, and gold and silver sales amounted to \$801,153; after various expenses were deducted the net gain for the year was \$1,952,495, and the balance December 31, 1928, was \$792,333. The following paragraphs are taken from the company's annual report for 1928:

The company owns 2,398 acres of lode mining claims, including its interest in the Superior North Queen group, 399 acres of mill sites, 325 acres of patented farm lands, and 18 town lots near Superior. * * *

During the year 2,427 cubic yards of rock were excavated in the cutting of shaft stations, pump stations, and pockets. No. 5 shaft was sunk a distance of 389 feet during the year and is now down 410 feet below the 2,550 level, which corresponds to the 2,960 level of the Magma mine. * * *

No. 2 shaft, which was damaged by fire last year, was cleaned out and repaired. It was necessary to retimber this shaft from the 1,400 level to a point 75 feet below the 2,550 level. * * *

A connection was made between the mine and No. 5 shaft on the 2,000 level. Considerable development work was done from No. 5 shaft on this level. This work disclosed several fissures, one of which may be the Magma vein, but none of these fissures contained any commercial ore. The minerals in these were zinc sulphide and pyrite. * * *

No development work was done below the 2,000 level of the mine through No. 2 or No. 3 shafts during the past year. * * *

The concentrator operations were continuous during the year. It was not necessary to run three sections of the concentrator full time to mill the tonnage produced by the mine. * * *

A 4-foot Symon's cone crusher was installed in the mill to replace the disk crushers which have been in operation there. * * *

Smelter operation during the year was uninterrupted except for ordinary repair work.

The Reymert mine, 8 miles southwest of Superior, was worked by lessees who shipped more than 7,000 tons of first-class siliceous silver ore to the Magma smelter at Superior. Although the output contained more than 120,000 ounces of silver, the property is not developed to great depth but is opened by shallow workings along the outcrop. In 1927 the mine produced about 140,000 ounces of silver. The Belmont Copper Mining Co., owning the Doggs and Goodwin groups near Superior, erected a 50-ton flotation plant and treated 3,684 tons of siliceous silver ore. The plant ran five months and produced 90 tons of concentrates containing about 106 ounces of silver and 0.45 ounce of gold to the ton. The concentrates and two cars of rich silver ore were smelted at the Magma plant. The mine is opened chiefly by drifts and crosscuts; 3,779 feet of development was done in 1928. Nearly 400 tons of oxidized lead ore was shipped from the Silver Bell property, several hundred tons of ore and old tailings was marketed from the Silver King dump near Superior, and one car of oxidized copper ore was shipped from the White Elephant property.

In 1927 eight lode mines in the Pioneer district of Gila and Pinal Counties produced 231,065 tons of ore, which yielded \$156,113 in gold, 930,033 ounces of silver, 28,220,529 pounds of copper, and 572,848 pounds of lead, valued in all at \$4,416,422, or \$19.11 in metals a ton.

Priorwood district.—One car of low-grade silver ore was shipped as a test from the Ruby Silver property.

Ripsey district.—The Florence Lead & Silver Mines (Inc.) operated its property 10 miles south of Wooley the entire year, and \$36,000 was said to have been spent in development. Two cars of rich silver ore were shipped to the Magma smelter at Superior, and one car of silver-lead ore was shipped to a custom flotation mill near Warren for testing purposes.

Saddle Mountain district.—The Hope Metals Co. operated property, including the Adjust, Laurence, Gold Gulch, and Mountain View groups, but shipped no ore. The company made large expenditures in development and road building and constructed a 50-ton flotation plant for silver-lead ore which was completed in February, 1929.

Summit district.—Two small lots of oxidized copper ore and copper-lead ore were shipped from the American group, 12 miles east of Miami, in the Summit district, part of which extends from Gila County into Pinal County.

SANTA CRUZ COUNTY

Thirty-five lode mines in Santa Cruz County produced 32,885 tons of ore and slag, or 26,637 tons more than was reported by 25 producers in 1927. Ore of shipping grade amounted to 5,260 tons and yielded metals valued at \$131,205. Ore to concentrating mills amounted to 27,208 tons and produced 1,934 tons of lead concentrates, 1,347 tons of zinc concentrates, and 20 tons of copper-lead concentrates, yielding metals valued at \$267,945. The total value of the metal output increased \$260,123 as a result of mining and milling lead-zinc ore at the Montana mine near Ruby.

Harshaw district.—Six lode mines in the Harshaw district produced 3,389 tons of ore, which yielded \$850 in gold, 50,642 ounces of silver, 7,612 pounds of copper, and 191,602 pounds of lead, valued in all at \$42,685, or \$12.60 in metals a ton. The output consisted of 235 tons of first-class ore of smelting grade and of 3,154 tons of concentrating ore which was reduced to 447 tons of concentrates. Most of the milling ore was mined at the World's Fair property, which was operated by the Zero Mining Co. The old mill, which was converted into a 60-ton flotation plant, was operated during September, October, and November, and about 400 tons of lead concentrates rich in silver were shipped to El Paso, Tex. Two cars of first-class silver ore were shipped to Hayden and Douglas for smelting. Early in 1929 the property was under the control of the Trench Mining Co.

The January Mines Co. shipped a car of first-class sulphide silver-lead ore and one lot of lead concentrates from the January property near Patagonia. The company owns no mill, but a little ore was tested in a neighboring plant. About 500 feet of work was done in drifting and shaft sinking, and a new ore body 450 feet long and 5 feet wide was said to have been opened. One car of oxidized lead ore was shipped early in the year from the Hardshell property, which was turned over to the Big Jim Mines (Inc.) in September. The company also operated the Abe Lincoln property, which is equipped with a 75-ton

flotation plant, and shipped one car of silver-lead concentrates, the result of former milling operations. Most of the work in 1928 was confined to testing the oxidized silver-lead ore of the Hardshell mine. A car of oxidized lead ore was also shipped from the Flux mine, and a little silver-lead ore and concentrate was marketed from the Trench-Josephine claims, 12 miles northeast of Patagonia, in Alum Gulch. More than 400 feet of drifting was done at the Garfield group, 6 miles southeast of Patagonia.

In 1927 five lode mines in the Harshaw district produced 2,013 tons of ore, which yielded \$223 in gold, 18,127 ounces of silver, 4,579 pounds of copper, and 358,262 pounds of lead, valued in all at \$33,672, or \$16.73 in metals a ton. The chief output was silver-lead concentrates from the Abe Lincoln or Blue Nose group.

Nogales district.—The output of the Nogales district consisted of a small lot of oxidized lead ore containing considerable gold from the Wolfe & Farmer prospect and of a sample lot of gold ore from a prospect 6 miles north of Nogales.

Oro Blanco district.—Four lode mines in the Oro Blanco district produced 23,440 tons of ore, which yielded gold, silver, copper, lead, and zinc valued in all at \$226,374, or \$9.66 in metals a ton. The entire output, except two small test lots of rich silver-lead ore and a little gold ore treated by amalgamation, was silver-lead-zinc ore of milling grade. The Montana mine at Ruby, owned and operated by the Eagle-Picher Lead Co., is opened by a vertical shaft 568 feet deep and by various levels. In 1928 more than 1,100 feet of work was done in drifting, crosscutting, and shaft sinking. The ore is chiefly silver-lead-zinc material of milling grade, containing tetrahedrite, galena, sphalerite, chalcopyrite, and pyrite. A new 250-ton mill using both tables and flotation machines was completed and operated in June. The plant ran four months and made two products—lead concentrates containing considerable gold and silver and high-grade zinc concentrates. The mine was the largest producer of zinc in Arizona in 1928 and a large producer of silver and lead. The output of this property will be greatly increased when the mill is operated regularly.

Pajarito district.—The output of the Pajarito district consisted of 40 tons of silver-lead ore from the White Oak and Sunset properties. The ore was treated by table concentration and some of the concentrates averaged 65 per cent of lead. In 1927 five lode mines in the Pajarito district produced 74 tons of ore valued at \$7,177, or \$96.99 in metals a ton.

Palmetto district.—The output of the Palmetto district was unusually small; it consisted of one sample lot of silver-lead ore from the Taft property.

Patagonia (Washington, Duquesne) district.—Ten lode mines in the Patagonia district produced 5,062 tons of ore and old slag, which yielded \$2,239 in gold, 9,384 ounces of silver, 668,514 pounds of copper, and 218,809 pounds of lead, valued in all at \$116,686, or \$23.05 in metals a ton. The entire output, except 397 tons of old slag resmelted and 124 tons of ore treated in a concentration plant, was first-class smelting ore. The greater part of the crude smelting ore was sulphide copper material from the Santo Nino mine, which was worked by lessees. About 3,600 tons of this material was shipped under bond to the smelter at Douglas by way of Zorilla, Sonora, Mexico,

after being hauled 10 miles to the loading station on the Southern Pacific Railroad. The mine also produced and marketed 15 tons of ore containing molybdenite. On January 1, 1929, the leasing company turned the property over to the original owner, the Southern Copper Mining Co.

Various lessees worked the Duquesne group of claims and shipped about 500 tons of ore containing chiefly silver, copper, and lead. The copper ore averaged about 7 per cent of copper and the lead ore contained approximately 8 per cent of lead. Several cars of oxidized lead ore and concentrates were shipped from the Mowry mine, 14 miles southeast of Patagonia, and nearly 400 tons of old slag containing silver and lead was shipped from the Mowry dump. Three cars of low-grade silver-copper ore were shipped from the dumps of the Morning Glory property; 4,235 feet of development was done in the mine. A flotation mill which was under construction will probably be completed in June, 1929. One car of sulphide copper ore was shipped from the Gladstone property in the Patagonia Mountains near Nogales, a car of sulphide lead ore was produced at the Denver group north of the Mowry mine, and several cars of low-grade copper ore and lead ore were shipped from various mine dumps.

In 1927 six lode mines in the Patagonia district produced 3,337 tons of ore, yielding \$1,624 in gold, 4,749 ounces of silver, 522,358 pounds of copper, and 47,954 pounds of lead, valued in all at \$75,767, or \$22.71 in metals a ton. The greater part of this output was first-class copper ore from the Santo Nino property.

Tyndall district (Alto).—Seven lode mines in the Tyndall district produced 391 tons of ore, which yielded \$295 in gold, 3,120 ounces of silver, 6,219 pounds of copper, and 145,494 pounds of lead, valued in all at \$11,455, or \$29.30 in metals a ton. The entire output was first-class smelting ore, nearly all of which was silver-lead ore and dump material from the Jefferson property. About six cars of ore containing approximately 30 per cent of lead were shipped from the mine, and five cars of silver-lead ore and low-grade silver-copper material were shipped from the dump. Small test lots of ore were shipped from the Toluachi, Three Stars, Alto, Hulda, and O. K. Franklin properties.

In 1927 seven lode mines in the Tyndall district produced 727 tons of ore, which yielded \$482 in gold, 9,503 ounces of silver, 10,291 pounds of copper, and 315,514 pounds of lead, valued in all at \$27,095, or \$37.27 in metals a ton. Most of the output was sulphide lead ore from the Jefferson mine and dump.

Wrightson district.—Three lode mines in the Wrightson district produced 556 tons of ore, which yielded \$171 in gold, 1,833 ounces of silver, 8,260 pounds of copper, and 102,017 pounds of lead, valued in all at \$8,349, or \$15.02 in metals a ton. The Victor property, 12 miles northwest of Patagonia, was operated a short time by various lessees, who shipped several cars of first-class sulphide lead ore and concentrates to the smelters at Douglas, Ariz., and El Paso, Tex. The Squaw Gulch Mining & Milling Co. worked the Mohawk mine and mill a short time and shipped two lots of copper-lead concentrates and one small lot of first-class sulphide copper-lead ore.

YAVAPAI COUNTY

The mine production of all metals except zinc in Yavapai County showed large increases in quantity and value. There were 64 mines producing, three more than in 1927. The output of ore, old smelter cleanings, etc., increased from 1,575,476 to 1,890,830 tons, gold from \$1,381,741 to \$1,404,620, silver from 2,584,676 to 2,619,217 fine ounces, copper from 141,641,714 to 165,296,914 pounds, lead from 110,327 to 162,780 pounds; the output of zinc decreased from 141,232 to 21,207 pounds. The total value increased from \$21,418,307 to \$26,750,353; it was larger than that of any county in the State and showed the largest increase.

Of the first-class ore shipped to smelters 1,428,412 tons, or all but 243 tons, was sulphide ore. The smelting ore yielded on the average \$16.17 in metals a ton. Concentrates amounting to 83,979 tons—83,911 tons derived from 461,012 tons of ore concentrated and 68 tons from gold and silver mills—yielded metals valued at \$3,548,288. Gold and silver bullion valued at \$3,249 was recovered from 995 tons of ore treated in amalgamation plants; 410 tons of old smelter cleanings shipped for resmelting yielded gold, silver, and copper valued at \$7,752; and copper from precipitates was valued at \$82,783. The placer output was \$3,912 in gold and 30 ounces of silver, compared with \$4,007 in gold and 24 ounces of silver in 1927.

Agua Fria district.—The mines in the Agua Fria district were not vigorously worked, but a lessee shipped four cars of sulphide copper ore from the Binghampton property. One car of similar ore was shipped from the Daisy mine, 7 miles northeast of Mayer. In 1927 three lode mines in the Agua Fria district produced 295 tons of ore, which yielded \$86 in gold, 231 ounces of silver, and 45,602 pounds of copper, valued in all at \$6,191, or \$20.99 in metals a ton.

Big Bug district.—Two placers and 10 lode mines in the Big Bug district produced 1,673 tons of ore and smelter cleanings, \$5,339 in gold, 7,910 ounces of silver, 264,814 pounds of copper, and 7,825 pounds of lead, valued in all at \$48,554. The ore was valued at \$28.73 in metals a ton. The output consisted of 50 tons of ore treated by amalgamation, 32 tons of ore concentrated, 1,181 tons of crude smelting ore, and 410 tons of old smelter cleanings. The Humboldt smelter of the Southwest Metals Co. was idle in 1928 and the company did no work at the Blue Bell mine, but nearly 1,000 tons of copper ore of smelting grade was shipped by various lessees. More than 400 tons of material containing gold, silver, and copper was cleaned up from the Humboldt plant and shipped to the Magma smelter at Superior. The Arizona National property was practically idle, but late in the year the Double O Metals Co. was organized to work the property and shipped a car of first-class lead ore and concentrates containing considerable silver. The mine is equipped with a 60-ton flotation plant, but it was operated only a short time. Several cars of sulphide copper ore were shipped from the Lone Pine property, 2 miles south of Humboldt; one car of oxidized copper ore was marketed from the Copper Star claim, 3 miles east of Mayer; and a little copper ore was produced from the Raymond claim. A little free gold ore from the Neptune property was treated by amalgamation, and a sample lot of gold concentrates was shipped as a test from the Blue Rock claim of the Yavapai Silver Co. Placer bullion valued at \$480

in gold and 6 ounces of silver was recovered from claims in the vicinity of Big Bug Creek.

In 1927 one placer and 11 lode mines in the Big Bug district produced 2,997 tons of ore and old tailings, \$13,252 in gold, 8,883 ounces of silver, 179,335 pounds of copper, and 3,480 pounds of lead, valued in all at \$42,000, an average of \$13.90 in metals a ton. Most of the output was old tailings from the dump at Humboldt.

Black Canyon district.—The Gold Crown group, or the old Silver Chord property, on Turkey Creek near Cleator produced three cars of siliceous silver ore and one car of sulphide silver-lead ore, which were of smelting grade. A car of lead-zinc ore was shipped to the flotation plant at Midvale, Utah, as a test. The Turkey mine, also near Cleator, produced a little ore containing chiefly gold and silver; the ore was shipped to the smelter at Hayden.

Black Hills district.—Three lode mines in the Black Hills district produced 117 tons of ore, which yielded \$52 in gold, 880 ounces of silver, 15,873 pounds of copper, and 7,633 pounds of lead, valued in all at \$3,296, or \$28.17 in metals a ton. The entire output was copper ore and lead ore of smelting grade. The Shylock group (Yaeger mine), 13 miles northeast of Dewey, produced one car of copper ore and one car of lead ore containing silver. A little oxidized copper ore was shipped from the Rainbow claim in Lang Canyon, 6 miles north of Dewey, and a car of similar material was marketed from the Kansas claim, 5 miles northeast of Dewey.

Black Rock district.—Two cars of copper ore were shipped from the Amazon group near Constellation, and a little gold bullion was recovered from a prospect north of Wickenburg. There was considerable activity during the latter part of the year at the Arizona Copper Belt property and other mines near Constellation and Wickenburg.

Copper Basin district.—Three cars of sulphide lead ore containing gold and silver were shipped from the United States Navy mine of the Verde Annex Mines Co. Considerable development in drifting and tunnel work was done at the Nine Strike mine, 7 miles north of Skull Valley.

Eureka district.—Three lode mines in the Eureka district produced 105 tons of ore, which yielded \$3,149 in gold, 155 ounces of silver, 170 pounds of copper, and 7,002 pounds of lead, valued in all at \$3,671, or \$34.96 in metals a ton. A little first-class sulphide lead ore was shipped from the Last Chance property at Hillside, and a test lot of gold ore was marketed from the Sierra Crest mine, 13 miles northwest of Hillside. Most of the district output, however, was gold ore produced by lessees from the Crosby mine, 16 miles west of Hillside and 4 miles southwest of the Santa Maria River. About half the ore output was treated by amalgamation, and the remainder was shipped for smelting. The Copper King mine, a large producer of zinc ore in 1926, was idle. A large deposit of low-grade copper ore, chiefly in the form of chalcocite, is being developed at the Arizona Bagdad property, which is equipped with a 50-ton pilot flotation mill, roaster, calcine-treatment plant, and electrolytic section. It is planned to treat the copper concentrates locally and make electrolytic copper.

In 1927 five lode mines in the Eureka district produced 329 tons of ore, which yielded \$1,603 in gold, 2,161 ounces of silver, 8,126 pounds of copper, 39,727 pounds of lead, and 141,232 pounds of zinc, valued in all at \$15,435, or \$46.91 in metals a ton. The zinc material

was mined at the Copper King mine of the Arizona Hillside Development Co.

Hassayampa district.—Two placers and 12 lode mines in the Hassayampa district produced 10,159 tons of ore, \$19,702 in gold, 25,185 ounces of silver, 331,955 pounds of copper, 18,498 pounds of lead, and 18,647 pounds of zinc, valued in all at \$84,448. The ore was valued at \$8.19 in metals a ton. The placer output consisted of \$1,202 in gold and 11 ounces of silver. Of the total ore produced 956 tons was directly smelted, 8,343 tons was concentrating ore, and 860 tons was treated in amalgamation mills. The Storm Cloud property, 12 miles from Prescott, was operated the entire year under lease and produced about 8,000 tons of ore containing gold, silver, and copper. The property was the largest producer in the district. More than 1,100 feet of development was done in drifting, crosscutting, and shaft sinking. A 50-ton flotation plant equipped with a ball mill, classifier, and flotation machines was worked the greater part of the year, and copper concentrates containing considerable gold and silver were shipped to the smelters at Hayden and Superior. The next largest producer in the district was the Blue Dick property, worked by lessees who shipped more than 700 tons of first-class smelting ore containing chiefly gold and silver. The Emporia mine near Prescott was worked from February until December by the Barbara Marshay Mines (Ltd.), and about 800 tons of gold ore was treated in a mill equipped with amalgamation plates and tables. The company marketed three small bars of gold bullion and shipped two cars of gold concentrates. About 300 feet of development was done, but operations were not profitable and work was suspended in January, 1929. Several cars of gold ore were shipped from the Snoozer and Dickinson claims, silver ore was shipped from the Monte Cristo and Sunset properties on Groom Creek, and a little gold ore from the Climax claim was treated by amalgamation. A car of lead-zinc ore containing silver was produced from the Smuggler property and shipped to Midvale, Utah, for custom milling. Small test lots of ore were produced from prospects on Groom Creek, and several small lots of placer gold were recovered from claims on Hassayampa River and on creeks near Prescott.

In 1927 seventeen lode mines in the Hassayampa district produced 1,716 tons of ore, yielding \$10,933 in gold, 30,004 ounces of silver, 65,321 pounds of copper, and 1,702 pounds of lead, valued in all at \$36,609, or \$21.33 in metals a ton. The largest producer was the Blue Dick property.

Humbug district.—A test lot of gold ore from the Fogarty property, 35 miles northeast of Hot Springs Junction, was treated in a small Gibson rod mill. A little gold bullion was sold to the mint at Denver, Colo. The Golden Wonder Mines (Inc.), owning property in the Humbug and Tip Top districts, was idle, but a new flotation plant was being constructed in 1929.

Martinez district.—Several thousand tons of mine-dump material containing gold and silver from the old Congress property was treated by a combination of gravity concentration and flotation. Concentrates containing chiefly gold were shipped to Superior for smelting.

Peck district.—Three lode mines in the Peck district produced 12,649 tons of ore, which yielded \$7,151 in gold, 31,410 ounces of silver, 878,473 pounds of copper, and 2,552 pounds of lead, valued in all at

\$152,174, or \$12.03 in metals a ton. The entire output was ore of smelting grade, and most of it was mined and shipped by lessees from the De Soto property of the Southwest Metals Co. About 12,500 tons of sulphide copper ore was shipped to Hayden and Superior for smelting, as the company's smelting plant at Humboldt was idle. Several cars of siliceous silver ore were shipped from the Swastika group, 1 mile east of Peck Canyon, by the Gold Crown Silver Mining Co. The silver occurs as cerargyrite, and some of the ore contained 162 ounces of silver to the ton. The mine is developed by three tunnels; 1,800 feet of development was done in 1928. A car of rich silver ore was also shipped from the Thunderbolt property, 4 miles south of Cleator.

Pine Grove district.—Several hundred tons of ore from the waste dump of the Saratoga property at Crown King was concentrated, and two cars of concentrates rich in gold were shipped to the Copper Queen lead smelter at Douglas.

Squaw Peak district.—No ore was shipped from the Squaw Peak district, but the Squaw Peak Copper Co. did 1,000 feet of tunnel work and some diamond drilling.

Tip Top district.—Small test lots of silver ore were shipped from the Tom Wade and Ben Warner claims near Canon. At the Kay mine, 14 miles south of Cleator, which is developed to a depth of 1,200 feet, 3,221 feet of diamond drilling was done.

Turkey Creek district (Bolada).—The Goodwin mine on upper Turkey Creek, 1 mile from Bolada, produced three cars of copper ore averaging about 164 ounces of silver to the ton.

Verde district (Jerome).—The value of the output of the Verde district in 1928 was the largest of any district in Arizona. The output consisted of copper ore of smelting and milling grade from the United Verde mine and first-class copper ore from the United Verde Extension property. Gold, silver, and copper are recovered in large quantities from both mines, but the output of the United Verde mine was several times that of the United Verde Extension property. The exact output of the district is not given in this report as the United Verde Copper Co. publishes no annual report and objects to having its production made public. A report¹⁸ on the geology of the district was published in 1926. The mine, mill, and smelting plant of the United Verde Copper Co. were reviewed by Robie¹⁹ in April and May.

The mine of the United Verde Copper Co. at Jerome and the milling and smelting plants at Clarkdale were operated the entire year. The ore is chiefly sulphide and most of it is directly smelted. About 27 per cent of the output is shipped to Clarkdale for treatment in the 1,200-ton flotation plant, which is close to the smelter. The concentrates and the first-class smelting ore are treated in the 5,000-ton smelting plant equipped with blast and reverberatory furnaces. Blast-furnace smelting was discontinued in May, 1927, but was resumed in April, 1928. As in 1927, the mine produced more gold, silver, and copper than any other single property in Arizona, and the company paid dividends aggregating \$4,500,000. The ore as taken from the

¹⁸ Lindgren, Waldemar, Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles, Ariz.: U. S. Geol. Survey Bull. 782, 1926, p. 54.

¹⁹ Robie, E. H., Innovations at the United Verde Mine: Eng. and Min. Jour., vol. 125, Apr. 14, 1928, p. 611; United Verde Concentrator and Smelter: Eng. and Min. Jour., vol. 125, May 5, 1928, p. 729; Further Particulars of the United Verde Reverberatory Practice: Eng. and Min. Jour., vol. 125, May 12, 1928, p. 773.

mine is separated into three classes—the heavy sulphide smelting ore; the schist ore, which is the sulphide ore mixed with the country rock; and the oxidized ore, which is removed from the open pit for leaching. Ore from the leaching dump contains considerable silica and iron. The extraction was high as the material came from the upper portions of the steam-shovel pit where the ore has been subjected to calcining by the fire that has been burning in the underground workings for the last 20 years. The mineralogy of this large ore deposit has been carefully studied by the research department of the company; as a result the recoveries in the mill by flotation have been greatly improved.

The mine is opened by a vertical shaft and various workings to the 3,150-foot level, and in 1928 the company did 18,904 feet of development. Both the milling ore and the first-class smelting ore contain various copper minerals. Recent study has disclosed several new minerals which earlier work had not identified. Pyrite and chalcopryrite are the chief minerals, and the flotation concentrates contain about 30 per cent of iron, 36 per cent of sulphur, and 5 per cent of silica. The milling ore contains about 3.15 per cent of copper, 0.6 ounce of silver, and 0.01 ounce of gold to the ton and, aside from the quartz and schist, 14 per cent of pyrite and 2 per cent of sphalerite. Most of the schist and about one-third of the pyrite are dropped in the tailings. The recovery is 94.5 per cent of the copper, 84 per cent of the silver, and 72 per cent of the gold. The mill was described in an article²⁰ published in 1926. The smelting plant consists chiefly of 4 blast furnaces, 24 roasters, 6 reverberatories, and 8 upright converters of the Great Falls type.

Most of the ore from the United Verde Extension mine was treated in the company's copper-smelting plant at Clemenceau, but about 8,000 tons of highly siliceous ore was shipped to Hayden for converter lining. The company's property at Jerome and the 800-ton smelting plant were operated the entire year. The mine ranked fifth as a producer of gold and silver in Arizona in 1928 and ninth as a producer of copper. The company produced 43,977,853 pounds of copper at the smelter, by treating 246,399 dry tons of company ore and 78 tons of custom ore, and 1,222,188 pounds of copper from shipments of highly siliceous copper ore. The ore smelted averaged 8.96 per cent of copper, 0.038 ounce of gold, and 1.63 ounces of silver to the ton. The average cost of producing a pound of copper in 1928 included these charges: Mining, 2.67 cents; smelting, 2.70 cents; freight on ore, 0.09 cent; freight (on bullion), refining, and selling, 1.82 cents; and other expenses, 0.22 cent; a total of \$7.50 cents a pound. This cost does not include charges for depreciation, depletion, or taxes. Gross revenue from metals and ore produced amounted to \$7,147,439, which, when added to other revenue (\$599,279), amounted to \$7,746,718. Deductions of charges for mine and smelter operation, freight, refining, selling, and other expenses, including taxes, amounted to \$3,921,297. Earnings from operations were \$3,825,421, less depletion and depreciation of \$2,805,395, leaving a net profit of \$1,020,026 to surplus.

Dividends paid to stockholders in 1928 amounted to \$2 a share, or \$2,100,000. Of this amount 61.58 cents a share was paid out of earned

²⁰ Lanning, John E., United Verde's New Concentrator: Eng. and Min. Jour., vol. 122, Dec. 18, 1926, p. 976.

surplus and \$1.3842 a share was paid out of depletion reserve account. The total dividends paid since the organization of the company in 1916 to the end of 1928 amounted to \$32,655,000, or \$31.10 a share. At the smelting plant, reverberatory furnace No. 1 was operated 299 days; No. 2, 313 days; and the blast furnace, 109 days. The mine is opened by a vertical shaft 1,900 feet deep and approximately 33 miles of other workings. Development in 1928 consisted of 2,553 feet of raising and 16,956 feet of drifting, as well as 3,715 feet of diamond drilling. The report continues:

We have measured ore in reserve amounting to about 778,620 tons of an average grade better than 8 per cent of copper.

The geology of the United Verde Extension ore occurrence is exceedingly complex and * * * for 14 years prior to the discovery of ore in December, 1914, others had spent large sums of money on development.

The ore bodies are all on the hanging wall side of the great Verde fault and until a year ago we had hopes that the roots from which this ore originated, or other ore bodies, would be found within the boundary lines of the company's property. * * *

Extensive development to the north and east in Jerome Verde ground and to the south in our own ground has been unproductive of ore discoveries and we are in the position of being obliged to accept the above figures of ore in sight and to realize that the probabilities of the discovery of further ore are exceedingly remote.

The smelting plant southeast of Clarkdale on the Verde River was fully described by Robie²¹ in May. The equipment includes crusher, sampler, Cottrell plant, 6 Wedge roasting furnaces, coal plant, 2 reverberatories, and 3 converters of the Great Falls type.

The Verde Central Mines (Inc.) continued to increase its ore reserves and develop its property at Jerome, which became a producer in 1929 after the new flotation mill was completed. The ore contains chiefly chalcopyrite and pyrite and is to be treated in the new 300-ton plant, construction of which was completed in December. The mill is equipped with a jaw crusher, rolls, two Hardinge ball mills, Dorr classifier, McIntosh flotation machines, Dorr thickeners, and American filter. Operations were reviewed in the annual report of the Calumet & Arizona Mining Co., from which the following paragraphs are taken:

The mine was operated continuously on two shifts per day during the past year.

Development work totaled 14,546 feet, consisting of 7,740 feet of drifting and crosscutting, 624 feet of raising, and 6,182 feet of diamond drilling. Considerable work was done for the purpose of getting the mine ready for production.

Much work was done in the Rock Butte ore zone on the 1,100, 1,200, and 1,300 levels. A siliceous ore body 250 feet long and averaging 15 feet wide was opened up on the 1,100 level in the north half of the Rock Butte claim. * * *

A new ore lens is being opened up on the west side of this fracture zone on the 1,100 level to the south of the 1,101 crosscut. To date this ore body is 90 feet long. * * *

Stoping has been started in the Silver Cliff vein on the 1,000 level and in the Rock Butte zone. * * *

On May 28, 1928, ground was broken for the new concentrator. This mill of 300 tons' daily capacity is now completed and ready for operation. * * *

A 24-inch gage railroad about 1,000 feet long was constructed from the mine to the mill.

Walker (Lynx Creek) district.—Two placers and one lode mine in the Walker district produced placer bullion and a little first-class lead ore valued together at \$874. The ore consisted of one test lot of sulphide material from the Farnum property, 1 mile northwest

²¹ Robie, E. H., United Verde Extension Smelter: Eng. and Min. Jour., vol. 125, May 19, 1928, p. 813.

of Walker. Placer bullion was recovered in small lots and sold to storekeepers at Walker and Prescott. No ore was shipped from the Sheldon property, formerly a large producer of gold, silver, copper, and lead, but the company did about 700 feet of development in drifting, crosscutting, and shaft sinking. Development was also continued at the property of the Hassayampa Gold Mining Co. (Inc.).

In 1927 three placers and one lode mine in the Walker district produced 3,836 tons of ore, \$5,603 in gold, 17,514 ounces of silver, 124,069 pounds of copper, and 41,069 pounds of lead, valued in all at \$34,374, a considerable decrease from the output of 1926 when metals valued at \$331,005 were produced, chiefly from the Sheldon property.

Walnut Grove district (Wagoner).—A little placer gold chiefly from the Mint property on Oak Creek, 7 miles south of Wagoner, and some copper precipitates recovered from the Zonia mine near Kirkland had a combined value of \$505. Considerable work was done in developing the McMahan group of the Arizona Metals (Inc.).

Weaver district.—Two placers and two lode mines in the Weaver district produced 501 tons of ore, \$4,245 in gold, 211 ounces of silver, 375 pounds of copper, and 1,916 pounds of lead, valued in all at \$4,533. Part of the placer gold, which was valued at \$1,144, recovered by various operators in the vicinity of Congress, was sold to storekeepers, and part was sold as nuggets for jewelry. The Octave mine, 10 miles from Congress, which was a large producer of gold in the past, was again operated in July by the Arizona-Eastern Gold Mines Co., and both mining and milling were started in November. A new 50-ton flotation mill was installed, and about 500 tons of ore was treated late in the year. Concentrates containing chiefly gold were smelted at Douglas.

White Picacho district.—The Diamond Joe mine, 10 miles east of Wickenburg, was worked by the Tindale Mining Co. (Inc.). Three cars of lead concentrates containing considerable silver were shipped to Douglas for smelting. The concentration plant was not operated regularly as the supply of water was not adequate.

YUMA COUNTY

The total value of the mine production of gold, silver, copper, and lead in Yuma County was \$56,570 in 1928, compared with \$53,299 in 1927. There was an increase in the output of gold and lead and a decrease in the output of silver and copper. Twenty-two lode mines produced 2,371 tons of ore. The placer output was \$1,014 in gold and 4 ounces of silver. Gold and silver bullion valued at \$1,822 was recovered from 216 tons of ore treated in amalgamation and cyanidation plants. The chief producers in the county were the Lion Hill mine near Parker and the Swansea property at Swansea.

Castle Dome district.—Six lode mines in the Castle Dome district produced 490 tons of ore, yielding \$77 in gold, 2,157 ounces of silver, 1,852 pounds of copper, and 196,773 pounds of lead, valued in all at \$13,019, or \$26.57 in metals a ton. The output consisted of 49 tons of first-class smelting ore and of 441 tons of milling ore which was reduced to 148 tons of concentrates. Several cars of concentrates and crude ore were shipped from mining claims near Dome, including the Sonora, Lady Edith, De Luce, and Silver Dollar properties. A small lot of oxidized lead ore was also shipped from the Mabel claim,

and a test lot of copper ore was marketed from the Copper Glance property. As there is little water for milling purposes, several of the properties are equipped with Stebbins dry concentrators. The concentrates from the Silver Dollar property contain about 54 per cent of lead and nearly 15 ounces of silver to the ton.

In 1927 five lode mines in the Castle Dome district produced 401 tons of ore, yielding \$66 in gold, 2,622 ounces of silver, 215 pounds of copper, and 171,930 pounds of lead, valued in all at \$12,413, or \$30.96 in metals a ton.

Cienega district.—The entire output of the Cienega district consisted of gold ore of smelting grade shipped from the Lion Hill property, 8 miles northeast of Parker, a station on the Santa Fe System. About 300 feet of development was done in the search of high-grade ore, and 169 tons of material, yielding approximately \$62 to the ton, was shipped to various smelters.

Ellsworth district.—Seven lode mines in the Ellsworth district produced 330 tons of ore, which yielded \$6,523 in gold, 583 ounces of silver, 14,184 pounds of copper, and 14,606 pounds of lead, valued in all at \$9,753, or \$29.55 in metals a ton. The output consisted of 210 tons of first-class smelting ore and 120 tons of concentrating ore. The Golden Eagle mine of the Bonanza & Golden Eagle Mining Co., 9 miles north of Salome, was operated by a lessee who shipped one car of rich gold ore and two cars of oxidized lead ore containing considerable gold. A little first-class copper ore and a car of copper concentrates from the Critic property near Wenden were shipped to the smelter at Hayden, and two cars of copper ore containing appreciable quantities of gold and silver were shipped from the Desert claim, 2 miles north of Vicksburg. A new hoist and headframe were installed, and the 5-stamp amalgamation-concentration mill was repaired. The mine, which is opened by a 2-compartment vertical shaft, was taken over late in the year by the Copperconda Mines Co., and comprehensive development was planned. One car of gold ore containing a little copper was shipped from the B. B. claim, and small test lots of copper ore were marketed from the Dellyers and Billie Joe claims. The Wenden Copper Co. did 1,500 feet of work in drifts and crosscuts, and a milling plant was planned for 1929.

In 1927 three lode mines in the Ellsworth district produced 299 tons of ore, which yielded \$1,686 in gold, 1,392 ounces of silver, and 9,952 pounds of copper, valued in all at \$3,780, or \$12.64 in metals a ton.

Kofa district.—A little exceptionally fine placer gold was recovered from claims near Yuma.

Planet district.—The Swansea mine, a large producer of copper ore especially in 1922 and 1923, was worked by the Clara-Swansea Mining Co., and nearly 1,000 tons of sulphide copper ore of fair grade was sold for smelting at Superior. The ore was shipped from Swansea by way of the Arizona & Swansea Railroad to Bouse, a station on the Southern Pacific Railroad.

Plomosa district.—Three placers and four lode mines in the Plomosa district produced 66 tons of ore, \$2,142 in gold, 38 ounces of silver, and 533 pounds of copper, valued in all at \$2,241. The ore had an average value of \$22.80 in metals a ton. A car of siliceous gold ore was shipped from the Black Mountain property, 3 miles west of Bouse, and a car of ore averaging nearly 2 ounces of gold to the ton was shipped from the Old Maid mine, where development consisted of 100

feet of crosscutting and drifting. New equipment was installed, and some shaft sinking done at the Dutchman property under the direction of the Great Western Gold & Copper Mining & Milling Co. A little gold bullion from former operations was marketed in San Francisco, Calif., and placer gold valued at \$734 was recovered from claims near Quartzsite.

In 1927 two placers and three lode mines in the Plomosa district produced ore and placer bullion valued at \$2,874.

Seneca district.—Two cars of copper ore containing a little gold and silver were shipped from the Sue property near Parker.

Silver district.—A little silver bullion was marketed from the James G. Blaine mine as a result of the operations of an 80-ton cyanidation plant owned by the Silver Mines Consolidated.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO¹

(MINE REPORT)

By CHAS. W. HENDERSON

SUMMARY

The total calculated gross value of the recovered and estimated recoverable gold, silver, copper, lead, and zinc from gravels handled and ores mined in Colorado in 1928 showed a decrease of 3½ per cent from the gross value in 1927, following a decrease of 19 per cent in 1927 from the gross value in 1926. There was a nominal increase in the output of gold, an increase of 10½ per cent in the output of silver, an increase of 67 per cent in the output of copper, a decrease of 26 per cent in the output of lead, and a decrease of 5 per cent in the output of zinc. There were 336 lode mines and 23 placers producing in 1928, compared with 330 lode mines and 19 placers in 1927, or an increase of 6 lode mines and 4 placers.

The total recorded value of gold, silver, copper, lead, and zinc (in terms of recovered metals) produced from Colorado ores and gravels from 1858 to 1928, inclusive, is \$1,624,698,531.²

The value of metal production herein reported has been calculated at the figures given in the table that follows. Gold is figured at the mint value for fine gold; that is, \$20.671835 an ounce. The silver price for 1919 is dealers' buying price, New York; for 1920 to 1922, New York market price for domestic silver only; for 1923, average price under the Pittman Act, January 1 to June 2, for domestic silver, and average New York price for all silver after that period; for 1924 and later years, average New York price for bar silver. The copper, lead, and zinc prices are weighted averages, for each year, of all grades of primary metal sold by producers.

Prices of silver, copper, lead, and zinc, 1919-1928

Year	Silver	Cop- per	Lead	Zinc	Year	Silver	Cop- per	Lead	Zinc
	<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>		<i>Per fine ounce</i>	<i>Per pound</i>	<i>Per pound</i>	<i>Per pound</i>
1919.....	\$1.12	\$0.186	\$0.053	\$0.073	1924.....	\$0.670	.131	\$0.080	\$0.065
1920.....	1.09	.184	.080	.081	1925.....	.694	.142	.087	.076
1921.....	1.00	.129	.045	.050	1926.....	.624	.140	.080	.075
1922.....	1.00	.135	.055	.057	1927.....	.567	.131	.063	.064
1923.....	.82	.147	.070	.068	1928.....	.585	.144	.058	.061

¹ Work on manuscript completed April, 1930.

² For details 1858 to 1923, see Henderson, Charles W., Mining in Colorado: U. S. Geol. Survey Prof. Paper 138, 1926, 263 pp.; for recapitulation by years 1858 to 1925, see Gold, Silver, Copper, Lead, and Zinc in Colorado: Mineral Resources of the United States, 1925, Pt. I, opp. p. 701.

Mine production of gold, silver, copper, lead, and zinc in Colorado, 1919-1928

Year	Mines producing			Ore sold or treated (short tons)	Gold			Silver (lode and placer)	
	Lode	Placer	Total		Lode	Placer	Total	Fine ounces	Value
1919-----	453	11	464	1,919,768	\$9,336,065	\$550,562	\$9,886,627	5,758,010	\$6,448,971
1920-----	405	11	416	1,571,293	7,061,731	514,588	7,576,319	5,409,335	5,896,175
1921-----	367	15	382	1,281,381	6,490,688	344,640	6,835,328	5,631,657	5,631,657
1922-----	460	20	480	1,412,100	6,017,016	356,403	6,373,419	5,855,911	5,855,911
1923-----	400	17	417	1,569,100	6,227,200	364,429	6,591,629	5,334,488	4,874,280
1924-----	340	18	358	1,514,182	8,174,610	418,506	8,593,116	3,254,370	2,180,428
1925-----	412	30	442	1,745,674	7,076,704	150,318	7,227,022	4,506,940	3,127,816
1926-----	387	31	418	1,839,740	7,031,079	46,954	7,078,033	4,704,122	2,935,372
1927-----	330	19	349	1,606,528	5,184,684	94,434	5,279,118	3,784,605	2,145,871
1928-----	336	23	359	1,426,084	5,243,470	61,406	5,304,876	4,052,253	2,370,568

Year	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
1919-----	3,560,207	\$662,198	37,070,241	\$1,964,722	37,220,493	\$2,717,096	\$21,679,614
1920-----	4,043,734	744,047	46,629,788	3,730,383	48,790,742	3,952,050	21,898,974
1921-----	4,153,442	555,794	19,660,466	884,721	2,360,000	118,000	14,005,500
1922-----	3,373,454	455,416	23,477,200	1,291,246	23,258,000	1,325,706	15,301,698
1923-----	4,248,109	624,472	45,698,185	3,198,873	54,152,000	3,682,336	18,471,590
1924-----	2,713,219	355,432	47,557,061	3,804,565	56,727,000	3,687,255	18,620,796
1925-----	2,360,500	335,191	62,966,000	5,478,042	61,621,000	4,683,196	20,851,267
1926-----	3,403,850	476,539	68,987,800	5,519,024	65,000,000	4,875,000	20,883,968
1927-----	5,670,581	742,846	66,772,557	4,206,671	71,729,000	4,590,656	16,965,162
1928-----	8,594,646	1,237,620	53,501,723	3,103,100	71,462,000	4,359,182	16,375,355

Gold and silver produced at placer mines in Colorado, 1919-1928, in fine ounces

Year	Sluicing and hydraulic		Dredging		Total	
	Gold	Silver	Gold	Silver	Gold	Silver
1919-----	409.18	87	26,224.26	7,056	26,633.44	7,143
1920-----	82.81	22	24,810.39	6,694	24,893.20	6,716
1921-----	323.63	96	16,348.32	4,346	16,671.95	4,442
1922-----	487.43	128	16,753.57	4,100	17,241.00	4,228
1923-----	299.22	66	17,360.03	4,056	17,659.25	4,122
1924-----	310.85	81	19,934.38	4,873	20,245.23	4,954
1925-----	445.77	101	6,825.86	1,798	7,271.63	1,899
1926-----	391.54	67	1,879.86	502	2,271.40	569
1927-----	364.38	73	4,203.87	1,063	4,568.25	1,136
1928-----	502.45	100	2,468.06	623	2,970.51	728

GOLD

The mine production of gold in Colorado in 1928 was 256,623.33 fine ounces, valued at \$5,304,876, an increase from 1927 of 1,246.05 fine ounces and of \$25,758.

The Cripple Creek district contributed \$3,059,181, or 58 per cent, of this total yield. That part of the San Juan region including Dolores, La Plata, Ouray, Rio Grande, San Juan, and San Miguel Counties yielded \$1,437,586, or 27 per cent of the State total. The largest increases were \$239,747 in Ouray County, \$214,980 in Park, \$112,049 in Rio Grande, \$73,988 in San Juan, \$33,852 in Gilpin, \$24,330 in La Plata, and \$14,225 in Dolores. The largest decreases were \$394,713 in San Miguel County, \$248,324 in Teller, \$35,108 in Summit, \$30,800 in Clear Creek, and \$2,841 in Lake.

The output of placer gold in 1928 was \$61,406, a decrease of \$33,028. Summit County, with 1 dredge, 1 hydraulic, and 5 sluice mines, produced 88 per cent of the placer gold. The other counties producing placer gold in 1928 were Adams, Chaffee, Clear Creek, Douglas, Eagle, Gilpin, Jefferson, and Moffat.

SILVER

The mine production of silver in Colorado in 1928 was 4,052,253 fine ounces, valued at \$2,370,568, an increase of 267,648 fine ounces in quantity and of \$224,697 in value over 1927, following a decrease of 919,517 ounces in quantity and of \$789,501 in value from 1926. The following counties of the San Juan region—Dolores, La Plata, Mineral, Ouray, San Juan, San Miguel—and Saguache County, geologically an outlier of the San Juan Tertiary flows, produced 3,031,759 ounces, valued at \$1,773,579, or 75 per cent of the State total in 1928. These same counties in 1927 produced 2,953,732 ounces, valued at \$1,674,766, or 78 per cent of the State total in 1927. Saguache County alone produced 22 per cent of the State total in both 1927 and 1928; it was the largest producer in 1928 and second only to San Miguel County in 1927. The largest increases were 179,646 ounces in Dolores County, 176,919 ounces in Eagle, 101,027 ounces in San Juan, 94,244 ounces in Clear Creek, 58,715 ounces in Saguache, and 15,281 ounces in La Plata. The largest decreases were 240,667 ounces in San Miguel County, 55,564 ounces in Pitkin, 32,671 ounces in Lake, and 31,284 ounces in Ouray.

COPPER

The mine production of copper in Colorado in 1928 was 8,594,646 pounds, valued at \$1,237,629, an increase of \$494,783 over 1927, following an increase of \$266,307 over 1926. Saguache County produced 50 per cent of the copper output, San Juan County more than 20 per cent, Eagle County 14 per cent, Dolores County 10 per cent, Lake County nearly 3 per cent, and San Miguel 1 per cent. The combined output of the 10 other counties producing in 1928 was only slightly more than 1 per cent of the total. Eagle County increased its production from 89,000 pounds, valued at \$11,659, in 1927 to 1,219,202 pounds, valued at \$175,565, in 1928. Other large increases were 921,496 pounds in quantity and \$176,616 in value in Saguache County; 756,014 pounds in quantity and \$110,569 in value in Dolores County; 206,439 pounds in quantity and \$49,867 in value in San Juan County; and 46,175 pounds in quantity and \$8,891 in value in Lake County. The largest decreases were 108,547 pounds in quantity and \$12,778 in value in San Miguel County, and 34,974 pounds in quantity and \$3,922 in value in Ouray County.

LEAD

The mine production of lead in Colorado in 1928, reckoned as lead in lead bullion and in leaded zinc oxide, was 53,501,723 pounds, valued at \$3,103,100, a decrease of \$1,103,571. There were decreases in all the important lead-producing counties in 1928, with the exception of Summit, Clear Creek, and Park Counties, in which minor increases were recorded in both quantity and value. Lead ores yielded

6,057,139 pounds and lead-zinc ores 35,939,766 pounds. Smelting ores of all kinds yielded 9,213,622 pounds, and concentrates of all kinds smelted yielded 44,288,101 pounds.

ZINC

The zinc-bearing ores marketed from Colorado in 1928 contained 71,462,000 pounds of recoverable zinc, valued at \$4,359,182, a decrease of 267,000 pounds in quantity and \$231,474 in value from 1927. Lake County again led in zinc production in 1928 with 29,603,000 pounds, or 41 per cent of the zinc output of the State, compared with 23,690,000 pounds, or 33 per cent, in 1927. San Juan ranked second in 1928 with 25,427,000 pounds, or 36 per cent of the total, compared with 22,869,000 pounds, or 32 per cent, in 1927. Of the other larger zinc-producing counties Dolores and Summit each showed a decrease of about 1,500,000 pounds of zinc and Eagle County showed a decrease of 5,000,000 pounds from the 1927 production.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1928, by counties, in terms of recovered metals

County	Mines producing			Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer	Total	Fine ounces	Value	Fine ounces	Value
Adams.....		3	3	200.56	\$4,146	29	\$17
Alamosa.....	1		1	.53	11		
Boulder.....	48		48	4,709.45	97,353	50,364	29,463
Chaffee.....	4	2	6	31.25	646	287	168
Clear Creek.....	51	1	52	1,569.09	32,436	130,925	76,591
Custer.....	4		4	1.60	33	1,395	816
Dolores.....	11		11	1,098.74	22,713	353,041	206,529
Douglas.....		1	1	15.14	313		
Eagle.....	2	1	3	804.62	16,633	262,660	153,656
Fremont.....	1		1	1.02	21	371	217
Gilpin.....	32	5	37	3,011.34	62,250	17,400	10,179
Gunnison.....	9		9	315.36	6,519	15,935	9,322
Hinsdale.....	5		5	4.35	90	2,793	1,634
Jefferson.....		1	1	4.84	100		
Lake.....	39		39	11,840.56	244,766	378,800	221,598
La Plata.....	8		8	2,294.57	47,433	24,193	14,153
Mesa.....	1		1			29	17
Mineral.....	1		1	23.71	490	210,159	122,943
Moffat.....		2	2	9.53	197		
Ouray.....	7		7	12,909.01	266,853	48,007	28,084
Park.....	10		10	12,321.07	254,699	8,684	5,080
Pitkin.....	10		10	2.08	43	96,764	56,607
Rio Grande.....	1		1	11,879.88	245,579	607	355
Saguache.....	2		2	1,129.51	23,349	903,759	528,699
San Juan.....	9		9	15,814.51	326,915	827,318	483,981
San Miguel.....	18		18	25,546.50	528,093	665,282	389,190
Summit.....	13	7	20	3,096.68	64,014	34,610	20,247
Teller.....	49		49	147,987.88	3,059,181	18,841	11,022
Total, 1927.....	336	23	359	256,623.38	5,304,876	4,052,253	2,370,568
	330	19	349	255,377.33	5,279,118	3,784,605	2,145,871

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1928, by counties, in terms of recovered metals—Continued

County	Copper		Lead		Zinc		Total value
	Pounds	Value	Pounds	Value	Pounds	Value	
Adams							\$4, 163
Alamosa							11
Boulder	3, 861	\$556	143, 793	\$8, 340			135, 712
Chaffee			21, 793	1, 264			2, 078
Clear Creek	5, 049	727	403, 310	23, 392	60, 000	\$3, 660	136, 806
Custer			15, 345	890			1, 739
Dolores	887, 014	127, 730	9, 051, 604	524, 993	9, 292, 000	566, 812	1, 448, 777
Douglas							313
Eagle	1, 219, 202	175, 565	1, 499, 000	86, 942	2, 800, 000	170, 800	603, 596
Fremont			4, 000	232	42, 000	2, 562	3, 032
Gilpin	30, 514	4, 394	107, 931	6, 260	12, 000	732	83, 815
Gunnison	2, 201	317	512, 569	29, 729	500, 000	30, 500	76, 387
Hinsdale	1, 610	232	45, 412	2, 634	22, 000	1, 342	5, 932
Jefferson							100
Lake	218, 625	31, 482	10, 336, 087	599, 493	20, 603, 000	1, 805, 783	2, 903, 122
La Plata	97	14	63, 000	3, 654			65, 254
Mesa	1, 202	173					190
Mineral			23, 000	1, 334			124, 767
Moffat							197
Ouray	50, 736	7, 306	101, 294	5, 875			308, 118
Park	6, 583	948	163, 724	9, 496			270, 223
Pitkin			1, 612, 311	93, 514	174, 000	10, 614	160, 778
Rio Grande							245, 934
Saguache	4, 300, 000	619, 200	4, 600, 000	266, 800			1, 438, 048
San Juan	1, 755, 653	252, 814	16, 694, 449	968, 278	25, 427, 000	1, 551, 047	3, 583, 035
San Miguel	110, 896	15, 969	6, 530, 431	378, 765			1, 312, 017
Summit	1, 403	202	1, 572, 670	91, 215	3, 530, 000	215, 330	391, 008
Teller							3, 070, 203
Total, 1927	8, 594, 646	1, 237, 629	53, 501, 723	3, 103, 100	71, 462, 000	4, 359, 182	16, 375, 355
	5, 670, 581	742, 846	66, 772, 557	4, 206, 671	71, 729, 000	4, 590, 656	16, 965, 162

Gold and silver produced at lode and placer mines in Colorado in 1928, by counties, in terms of recovered metals

County	Lode mines				Placer mines			Grand total value
	Ore sold or treated	Gold	Silver	Total value	Gold	Silver	Total value	
	<i>Short tons</i>		<i>Fine ounces</i>			<i>Fine ounces</i>		
Adams					\$4, 146	29	\$17	\$4, 163
Alamosa	1	\$11		\$11				11
Boulder	19, 599	97, 353	50, 364	\$29, 463				126, 816
Chaffee	65	103	282	165	538	5	3	814
Clear Creek	44, 408	32, 295	130, 923	76, 590	141	2	142	109, 027
Custer	48	33	1, 395	816				849
Dolores	58, 744	22, 713	353, 041	206, 529				229, 242
Douglas					313		313	313
Eagle	28, 616	16, 573	262, 660	153, 656	60		60	170, 289
Fremont	157	21	371	217				238
Gilpin	13, 180	60, 331	17, 353	10, 169	1, 919	17	10	72, 429
Gunnison	2, 379	6, 519	15, 935	9, 322				15, 841
Hinsdale	106	90	2, 793	1, 634				1, 724
Jefferson					100		100	100
Lake	121, 415	244, 766	378, 800	221, 598				466, 364
La Plata	8, 120	47, 433	24, 193	14, 153				61, 586
Mesa	2		29	17				17
Mineral	4, 021	490	210, 159	122, 943				123, 433
Moffat					197		197	197
Ouray	10, 653	266, 853	43, 007	28, 084				294, 937
Park	2, 918	254, 699	8, 684	5, 080				259, 779
Pitkin	14, 339	43	96, 764	56, 607				56, 650
Rio Grande	604	245, 579	607	355				245, 934
Saguache	110, 598	23, 349	903, 759	528, 699				552, 048
San Juan	326, 110	326, 915	827, 318	483, 981				810, 896
San Miguel	188, 406	528, 093	665, 282	389, 190				917, 283
Summit	24, 520	10, 022	33, 935	19, 852	53, 992	675	335	84, 261
Teller	447, 075	3, 059, 181	18, 841	11, 022				3, 070, 203
Total, 1927	1, 426, 084	5, 243, 470	4, 051, 525	2, 370, 142	7, 613, 612	728	426	7, 675, 444
	1, 606, 528	5, 184, 684	3, 783, 469	2, 145, 227	7, 329, 911	94, 434	1, 136	7, 424, 989

Gold and silver produced at placer mines in Colorado in 1928, by counties, in fine ounces

County	Sluicing and hydraulic		Dredging		Total	
	Gold	Silver	Gold	Silver	Gold	Silver
Adams.....	200.56	29	-----	-----	200.56	29
Chaffee.....	26.03	5	-----	-----	26.03	5
Clear Creek.....	6.82	2	-----	-----	6.82	2
Douglas.....	15.14	-----	-----	-----	15.14	-----
Eagle.....	2.90	-----	-----	-----	2.90	-----
Gilpin.....	92.83	17	-----	-----	92.83	17
Jefferson.....	4.84	-----	-----	-----	4.84	-----
Moffat.....	9.53	-----	-----	-----	9.53	-----
Summit.....	143.80	47	2,468.06	628	2,611.86	675
Total, 1927.....	502.45	100	2,468.06	628	2,970.51	728
	364.38	73	4,203.87	1,063	4,568.25	1,136

MINING INDUSTRY

Operating details are given under the caption, "Review by counties and districts," but some of the more significant are briefly noted here. In the Cripple Creek district the gross value of ore shipped by the Portland Gold Mining Co. increased from \$149,302 to \$200,012, but the gross value recovered at that company's Independence mill dropped from \$660,293 to \$473,840. The mill was closed December 1, 1928. The quantity of ore from the Cresson mine for the fiscal year ended August 31, 1927, was 104,645 tons of an average gross value of \$12.95; for the fiscal year ended August 31, 1928, it was 106,041 tons of an average gross value of \$9.21; no improvement in grade was made in the last four months of the calendar year 1928. The United Gold Mines in 1928 produced 97,626 tons of ore of an average gross value of \$9.08, compared with 93,840 tons of an average gross value of \$8.16 in 1927. The Elkton and Queen became important producers. At Colorado Springs the Golden Cycle mill was operated continuously, mainly on Cripple Creek mine and dump ore. At Canon City the Empire Zinc Co.'s magnetic separation plant was dismantled shortly after the beginning of the year, but the company's zinc oxide plant was operated steadily. At Ilse development only was done at the Terrible mine, from which high-grade lead (cerussite) concentrates had been produced up to October, 1927. At Bonanza the Rawley continued in operation at a rate of 325 tons of ore a day. In the Summitville district the Little Annie mine produced \$245,579 in gold. At Creede silver production increased because of ore discoveries in fissures in the hanging wall of the Amethyst fault fissure. From White Pine zinc-lead-silver milling ore was shipped. At Eureka the Sunnyside selective flotation mill operated steadily at a rate of 900 tons of ore a day. Near Silverton the ore found in the Mayflower claim by the Shenandoah-Dives Syndicate's adit was milled successfully in the pilot mill installed in the old Iowa-Tiger mill.

At Rico the International selective flotation 225-ton mill remained idle, but shipments from the district—mostly to Utah custom milling plants—aggregated 58,443 tons of ore, compared with a pro-

duction of 60,743 tons in 1927. At Ophir the Carbonero selective flotation mill was the only mill operated steadily. At Telluride the Smuggler-Union was the only important producer, and it closed in December, 1928. In Ouray County the operations at the Camp Bird upper levels were continued by lessees; the Wanakah concentration mill was operated part time; and high-grade specimen gold was discovered in the Jonathan. At Aspen silver and lead output again decreased. At Rifle the 110 to 140 ton vanadium plant operated steadily. At Gilman silver-iron pyrite and silver-iron chalcopyrite ore was shipped throughout the year, but no zinc-lead-silver-gold-iron ore was shipped, pending the contemplated building of a selective flotation mill at the mine. At Leadville production showed a slight increase in total calculated gross value of metals recovered from ores mined. At Climax the Climax Molybdenum Co.'s flotation mill was operated at an average rate of 892 tons of ore a day for 365 days. In Summit County, at Montezuma, one mill was operated part time; at Breckenridge the Wellington's new selective flotation mill resumed operations in July, 1928, the pilot mill of the Royal Tiger was operated part time, and the Blue River dredge was operated from January to August 10, except March. In Park County shipments of gold ore from the London Extension increased heavily. In Boulder County the Boulder County mill was idle. In the Silver Plume-Georgetown district the East Butte mill was again in operation and the St. George mill was operated. At Empire the Gold Dirt mill was operated. At Idaho Springs the Argo remodeled mill at the mouth of the Argo adit was operated on ore from the unwatered Kansas-Ophir-Phoenix group, in the Nevada-ville district, Gilpin County. Recovery of fine gold from gravel and sand washing plants continued in Adams County.

ORE CLASSIFICATION

Ore sold or treated in Colorado in 1928, with content in terms of recovered metals

Source	Ore		Gold		Silver	
	Short tons	Per cent	Fine ounces	Per cent	Fine ounces	Per cent
Dry gold ore.....	511,353	35.86	206,384.12	80.42	163,213	4.03
Dry gold and silver ore.....	194,831	13.66	30,198.82	11.77	624,909	15.42
Dry silver ore.....	188,271	13.20	1,735.74	.68	1,530,209	37.76
	894,455	62.72	238,318.68	92.87	2,318,331	57.21
Copper ore.....	11,983	.84	769.31	.30	235,581	5.81
Copper-lead ore.....	366	.03	315.29	.12	14,292	.35
Lead ore.....	26,687	1.87	1,181.56	.46	233,611	5.77
Lead-zinc ore.....	492,593	34.54	13,068.03	5.09	1,249,710	30.84
	531,629	37.28	15,334.19	5.97	1,733,194	42.77
Total, lode mines.....	1,426,084	100.00	253,652.87	98.84	4,051,525	99.98
Total, placers.....			2,970.51	1.16	728	.02
	1,426,084	100.00	256,623.38	100.00	4,052,253	100.00
Total, 1927.....	1,606,528		255,377.33		3,784,605	

Ore sold or treated in Colorado in 1928, with content in terms of recovered metals—Continued

Source	Copper		Lead		Zinc	
	Pounds	Per cent	Pounds	Per cent	Pounds	Per cent
Dry gold ore.....	69,840	0.81	568,047	1.06	12,000	0.02
Dry gold and silver ore.....	364,529	4.24	3,632,672	6.79	-----	-----
Dry silver ore.....	4,427,323	51.51	7,166,732	13.40	-----	-----
	4,861,692	56.56	11,367,451	21.25	12,000	.02
Copper ore.....	1,299,636	15.12	35,157	.07	-----	-----
Copper-lead ore.....	23,116	.27	102,210	.19	-----	-----
Lead ore.....	91,694	1.07	6,057,139	11.32	-----	-----
Lead-zinc ore.....	2,318,508	26.98	35,939,766	67.17	71,450,000	99.98
	3,732,954	43.44	42,134,272	78.75	71,450,000	99.98
	8,594,646	100.00	53,501,723	100.00	71,462,000	100.00
Total, 1927.....	5,670,581	-----	66,772,557	-----	71,729,000	-----

METAL CONTENT OF ZINC-BEARING MATERIALS

The following table gives the kind and grade of zinc-bearing materials marketed in 1928.

Zinc and zinc-lead ore and zinc concentrates as marketed from Colorado mines and mills in 1928, in terms of original content

Classification	County	Dry weight	Gold		Silver	
			Content	Average assay	Content	Average assay
Sulphide:		<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Fine ounces</i>
Crude milling ore and middlings.....	Dolores, Hinsdale, and San Juan.	26,438	1,990.42	0.075	240,683	9.08
Crude milling ore.....	Fremont.....	157	2.74	.017	458	2.92
Do.....	Gunnison.....	1,427	22.40	.016	11,234	7.87
Total crude milling ore and middlings.....		28,022	2,015.56	.072	251,775	8.98
Crude milling and smelting ore.....	Lake and Pitkin.....	21,077	132.61	.006	87,592	4.16
Zinc concentrates.....	Dolores and San Juan.....	34,905	2,321.39	.067	236,755	6.78
Do.....	Eagle, Lake, and Summit.	31,382	362.50	.012	99,844	3.18
Do.....	Clear Creek and Gilpin.....	105	2.90	.028	690	6.57
Total zinc concentrates.....		66,392	2,686.79	.040	337,289	5.08
Grand total.....		115,491	4,834.96	-----	676,656	-----

Classification	Copper		Lead		Zinc	
	Content	Wet assay	Content	Wet assay	Content	Assay
Sulphide:	<i>Pounds</i>	<i>Per cent</i>	<i>Pounds</i>	<i>Per cent</i>	<i>Pounds</i>	<i>Per cent</i>
Crude milling ore and middlings.....	913,892	1.73	5,737,076	10.85	6,754,843	12.77
Crude milling ore.....	-----	-----	6,118	1.95	56,245	17.91
Do.....	3,040	.11	537,784	13.84	756,390	26.50
Total crude milling ore and middlings.....	916,932	1.64	6,280,978	11.21	7,567,478	13.50
Crude milling and smelting ore.....	-----	-----	4,734,028	11.23	12,236,737	29.03
Zinc concentrates.....	892,296	1.28	3,919,419	5.61	36,461,129	52.23
Do.....	270,130	.43	1,592,022	2.54	32,084,351	51.12
Do.....	1,072	.51	6,517	3.10	90,108	42.91
Total zinc concentrates.....	1,163,498	.88	5,517,958	4.16	68,635,588	51.69
Grand total.....	2,080,430	-----	16,532,964	-----	88,439,803	-----

METALLURGIC INDUSTRY

Since the very earliest days of mining in Colorado milling of ores has been a prominent feature in mining operations, first by amalgamation of the gold ores, supplemented after the building of the first smelter in 1868 by concentration with contrivances such as the Gilpin County bumping table and after 1896 by the Wilfley table. Chlorination was tried out on gold and silver ores but was superseded by cyanidation. Nevertheless, of the total ore mined a relatively large proportion was formerly sent crude to smelters. In 1904 (the first year for which figures showing the relative quantities of milling and smelting ore are available) direct smelting ore constituted 50 per cent of the ore mined. In 1909³ the relative percentages were as follows: 24 per cent shipped direct to smelters; 16 per cent to mills equipped for concentration only; and 60 per cent to chlorination, cyanidation, and amalgamation mills (hereafter referred to as gold and silver mills), the amalgamation mills nearly always being followed by supplementary concentration. The approximate quantity of smelting ore in 1904 was 1,166,940 tons and the actual quantity in 1909 was 541,972 tons.

The following table shows the quantities of crude ore shipped to smelters, to gold and silver mills, and to mills for concentrating only and the total quantity of concentrates produced, from 1909 to 1928, inclusive.

Colorado crude ores treated and concentrates smelted, 1909-1928

Year	Crude ore						Concen- trates smelted (short tons)	
	Smelted		To gold and silver mills		To mills for concentrating only			Total (short tons)
	Short tons	Per cent of total ore	Short tons	Per cent of total ore	Short tons	Per cent of total ore		
1909.....	541,972	24	1,320,111	60	357,658	16	2,219,741	154,091
1910.....	514,008	21	1,455,983	60	464,673	19	2,434,664	237,342
1911.....	538,774	23	1,373,879	58	465,283	19	2,377,936	201,010
1912.....	617,726	24	1,435,837	56	523,063	20	2,576,626	224,722
1913.....	664,998	24	1,610,335	59	459,533	17	2,734,866	218,291
1914.....	668,143	25	1,630,640	61	378,743	14	2,677,526	188,770
1915.....	568,418	21	1,611,335	59	557,267	20	2,737,020	233,965
1916.....	552,904	21	1,442,139	53	702,200	26	2,697,243	288,211
1917.....	502,308	19	1,487,304	55	699,094	26	2,688,706	280,563
1918.....	414,177	18	1,345,451	58	555,262	24	2,314,890	226,292
1919.....	284,409	15	1,195,986	62	439,373	23	1,919,768	100,775
1920.....	267,280	17	626,900	40	677,113	43	1,571,293	119,233
1921.....	190,348	15	884,763	69	206,270	16	1,281,381	49,140
1922.....	260,607	19	849,261	60	302,232	21	1,412,100	60,290
1923.....	202,250	13	817,328	52	549,522	35	1,569,100	150,566
1924.....	184,454	12	867,367	57	462,361	31	1,514,182	130,740
1925.....	223,566	13	898,488	51	623,620	36	1,745,674	164,299
1926.....	214,434	12	958,924	52	666,382	36	1,839,740	156,943
1927.....	105,397	7	774,162	48	726,969	45	1,606,528	172,569
1928.....	82,876	6	630,718	44	712,490	50	1,426,084	158,736
Total, 1909-1928...	7,599,049	18	23,216,911	56	10,529,108	26	41,345,068	3,516,548

Of the ore mined the percentage shipped crude to smelters has gradually declined from 24 per cent in 1909 to 21 per cent in 1915, to 17 per cent in 1920, to 13 per cent in 1925, and to less than 6 per

³ Mineral Resources, 1909, Pt. I, p. 291.

cent in 1928; the percentages treated in gold and silver mills are as follows: 60 per cent in 1909, 59 per cent in 1915, 40 per cent in 1920, 51 per cent in 1925, and 44 per cent in 1928; and the percentages treated in mills for concentrating only are as follows: 16 per cent in 1909, 20 per cent in 1915, 43 per cent in 1920, 36 per cent in 1925, and 50 per cent in 1928. These figures indicate clearly the decline in the quantity, both actual and relative, of direct smelting ores and the comparative importance of the wet metallurgic industry.

Custom reduction plants.—The following custom reduction plants operated in the State during 1928: The lead bullion-lead copper matte smelters at Durango and Leadville; the zinc oxide plant at Canon City; the roast-amalgamation-cyanidation mill at Colorado Springs; the Argo selective flotation mill at Idaho Springs; the Portland nonroast cyanidation-concentration mill at Victor; the sampling plants at Victor, Idaho Springs, and Boulder; the arsenic-cadmium plant at the old Globe smelter, Denver; and the Leadville zinc-lead flotation mill at Leadville.

Mines in Colorado in 1928 produced 1,426,084 tons of ore, of which 82,876 tons, or 5.81 per cent, was shipped crude to smelters; 630,718 tons, or 44.23 per cent, went to amalgamation and cyanidation mills with or without supplementary concentration; and 712,490 tons, or 49.96 per cent, went to mills equipped for concentration only. Of the 630,718 tons of ore to amalgamation and cyanidation mills 168,320 tons was given additional treatment by concentration methods. This tonnage, added to the 712,490 tons, gives a total of 880,810 tons of ore treated by concentration methods, equivalent to 61.76 per cent of the State total.

Amalgamation and cyanidation.—The 630,718 tons of ore treated at amalgamation and cyanidation mills was classified as follows: Dry gold ore, 467,314 tons, or 74.09 per cent; dry gold and silver ore, 159,939 tons, or 25.36 per cent; and dry silver ore, 3,465 tons, or 0.55 per cent. Of the total material treated by amalgamation and cyanidation 481,692 tons was ore amalgamated, 149,026 tons was ore cyanided direct, and 313,127 tons was sands and slimes (from ores and from Teller County concentrates first treated by amalgamation) given an additional treatment by cyanidation. Ten amalgamation mills, 2 cyanidation mills, and 1 combined amalgamation and cyanidation mill treated this ore, from which was recovered 184,373.13 ounces of gold and 211,670 ounces of silver in the form of gold-silver bullion. Three mills (1 amalgamation-concentration mill in San Miguel County, 1 cyanidation-concentration mill in Teller County, and 1 combined amalgamation-cyanidation mill in El Paso County) treated 98 per cent of the total tonnage treated in gold and silver mills and recovered 93 per cent of the gold and 98 per cent of the silver recovered as bullion.

Concentrating plants.—The 880,810 tons of ore (including the 168,320 tons first treated by amalgamation) treated by concentration was classified as follows: Dry gold ore, 47,721 tons, or 5.42 per cent; dry gold and silver ore, 192,679 tons, or 21.88 per cent; dry silver ore, 151,957 tons, or 17.25 per cent; lead ore, 16,702 tons, or 1.90 per cent; lead-zinc ore, 471,751 tons, or 53.56 per cent.

Thirty-eight concentrating plants (including four using preliminary amalgamation) in Colorado were active in 1928. Nine of these

employed tables, 1 employed jigs and tables, 4 were combined table and flotation mills (one of which also used Harz jigs), and 23 were all-flotation mills, with or without tables for control. One mill was equipped with magnetic-separation machines only.

Flotation concentration.—Of the total Colorado ore concentrated, flotation plants in Colorado and Utah treated 807,811 tons, or 91.71 per cent. The ore treated by flotation is classified as follows: Dry gold ore, 38,350 tons, or 4.35 per cent of the total ore concentrated; dry gold and silver ore, 163,732 tons, or 18.59 per cent; dry silver ore, 150,557 tons, or 17.09 per cent; lead-zinc ore, 455,172 tons, or 51.68 per cent.

From ores mined in the State a total of 150,720 tons of flotation concentrates was produced, classified as follows: Dry gold concentrates, 1,796 tons, or 1.19 per cent of the total flotation concentrates; dry gold and silver concentrates, 17 tons, or 0.01 per cent; dry silver concentrates, 3,370 tons, or 2.24 per cent; copper concentrates, 322 tons, or 0.21 per cent; copper-lead concentrates, 39,360 tons, or 26.11 per cent; lead concentrates, 35,738 tons, or 23.71 per cent; lead-zinc concentrates and middlings, 3,812 tons, or 2.53 per cent; and zinc concentrates, 66,305 tons, or 44 per cent. The following tables give the classification of concentrates from all concentrating plants and the classification of flotation concentrates, in terms of gross metal content.

Gross metal content of concentrates produced at concentrating plants from ores mined in Colorado in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper (wet assay)	Lead (wet assay)	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry gold.....	2,345	8,089.72	58,872	41,635	189,483	113,415
Dry gold and silver.....	17	54.57	2,090		552	
Dry silver.....	3,370	185.39	10,470	123,508	135,010	391,864
Copper.....	322	1,620.22	7,634	30,906	18,459	11,223
Copper-lead.....	39,759	13,685.19	1,495,934	7,188,446	20,989,593	6,271,729
Lead.....	38,281	22,107.08	1,204,920	776,765	24,559,186	5,159,711
Lead-zinc.....	3,812	1,363.86	57,303	171,596	1,369,218	1,874,551
Zinc.....	70,830	2,742.20	355,296	1,315,625	5,839,595	73,288,557
	158,736	49,848.23	3,192,519	9,648,481	53,101,096	87,111,050

Gross metal content of concentrates produced at flotation plants from ores mined in Colorado in 1928

Class of concentrate	Concentrates produced (dry weight)	Gross metal content				
		Gold	Silver	Copper (wet assay)	Lead (wet assay)	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry gold.....	1,796	4,443.52	47,706	12,941	131,426	48,142
Dry gold and silver.....	17	54.57	2,090		552	
Dry silver.....	3,370	185.39	10,470	123,508	135,010	391,864
Copper.....	322	1,620.23	7,634	30,906	18,459	11,223
Copper-lead.....	39,360	12,153.49	1,479,227	7,135,614	20,873,047	6,241,889
Lead.....	35,738	21,623.09	1,143,909	739,467	22,019,348	4,838,626
Lead-zinc.....	3,812	1,363.86	57,303	171,596	1,369,218	1,874,551
Zinc.....	66,305	2,739.30	354,006	1,314,553	5,482,898	69,714,469
	150,720	44,183.45	3,102,945	9,528,585	50,029,958	83,120,764

The flotation concentrates yielded 16.9 per cent of the total gold produced in Colorado, 73.3 per cent of the silver, 80.9 per cent of the copper, 77.9 per cent of the lead, and 82.5 per cent of the zinc.

Two selective flotation plants in Utah treated 24,445 tons of Colorado ore, or 3 per cent of the total Colorado ore treated by flotation. This ore came from Fremont, Dolores, Gunnison, Hinsdale, and Lake Counties. Lead-zinc ore treated in five Colorado and two Utah preferential flotation mills constituted 51.7 per cent of the total ore concentrated. Three of these Colorado mills—the Rico International, the Colorado Zinc-Lead, and the Sunnyside—treated 410,917 tons of lead-zinc ore, 87 per cent of the total lead-zinc ore milled and 51 per cent of the total ore treated by flotation. These three mills produced 88,155 tons of lead and zinc concentrates (58.5 per cent of the total concentrates from flotation), containing 29.1 per cent of the gold, 37.3 per cent of the silver, 31.2 per cent of the copper, 64.2 per cent of the lead, and 82 per cent of the zinc recovered by all flotation plants. (All percentages are based on gross metal content of concentrates.)

Mine production of metals in Colorado in 1928, by methods of recovery

Method of recovery	Material treated	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Ore amalgamated.....	481,692	56,781.62	14,964	-----	-----	-----
Ore, sands, and slimes cyanided...	462,153	127,591.51	196,706	7,035,758	44,288,101	61,819,000
Concentrates smelted.....	158,736	49,062.03	3,060,601	1,558,888	9,213,622	9,643,060
Ore smelted.....	82,876	20,217.71	779,254	-----	-----	-----
Placer.....	-----	2,970.51	728	-----	-----	-----
	-----	256,623.38	4,052,253	8,594,646	53,501,723	71,462,000

Ores, sands, and slimes treated by amalgamation and cyanidation and gold and silver contained in bullion and precipitates in Colorado in 1928

Process	Material treated	Gold in bullion	Silver in bullion	Quicksilver purchased	Sodium cyanide used
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>
Amalgamation.....	481,692	56,781.62	14,964	2,460	-----
Cyanidation.....	¹ 462,153	127,591.51	196,706	-----	² 384,351
	-----	184,373.13	211,670	2,460	² 384,351

¹ Includes 149,026 tons of raw ore treated by direct cyanidation and 313,127 tons of sands and slimes from ore and from Teller County concentrates first amalgamated.

² Reduced to equivalent of 96 to 98 per cent strength. Actually 768,702 pounds of cyanamid of approximately 48 to 49 per cent strength.

Mine production of metals from gold and silver mills in Colorado in 1928, by counties

County	Ore treated	Recovered in bullion		Concentrates and recovered metal					
		Gold	Silver	Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Alamosa.....	1	0.53	-----	-----	-----	-----	-----	-----	-----
Boulder.....	3,153	1,266.86	827	38	107.68	91	-----	-----	-----
Clear Creek.....	3,712	933.71	1,192	-----	-----	-----	-----	-----	-----
Gilpin.....	2,271	734.18	1,698	94	75.99	796	-----	51,726	12,000
Gunnison.....	700	176.70	241	-----	-----	-----	-----	-----	-----
Lake.....	2,815	5,981.99	5,825	-----	-----	-----	-----	-----	-----
La Plata.....	2	50.41	32	-----	-----	-----	-----	-----	-----
Mineral.....	3,440	13.61	171,166	-----	-----	-----	-----	-----	-----
Ouray.....	6,512	5,820.98	1,866	510	3,541.14	10,991	22,951	50,207	-----
Park.....	488	1,854.96	417	29	126.19	158	278	4,615	-----
Rio Grande.....	604	11,879.88	607	-----	-----	-----	-----	-----	-----
Saguache.....	3	6.05	-----	-----	-----	-----	-----	-----	-----
San Miguel.....	159,922	7,663.92	8,806	16,445	16,679.00	488,707	24,000	3,138,000	-----
Summit.....	20	1.47	152	-----	-----	-----	-----	-----	-----
Teller.....	447,075	147,987.88	18,841	(¹)	(¹)	(¹)	-----	-----	7
Total, 1927.....	630,718 774,162	184,373.13 191,317.26	211,670 123,241	17,116 25,985	20,530.00 29,512.28	500,743 633,546	47,229 61,201	3,244,548 6,207,331	12,000 456,000

¹ Concentrates produced were cyanided and contents are included in bullion recovered.*Mine production of metals from concentrating mills in Colorado in 1928, by counties*

County	Ore treated	Concentrates and recovered metal					
		Concentrates produced	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Boulder.....	16,300	652	3,234.49	34,407	3,341	124,169	-----
Clear Creek.....	40,363	1,099	446.08	112,695	630	320,667	60,000
Dolores.....	56,473	21,098	1,010.50	326,003	791,517	8,597,222	9,203,000
Eagle and Summit.....	40,505	11,070	448.96	40,075	1,403	2,814,819	6,330,000
Fremont.....	157	51	1.02	371	-----	4,000	42,000
Gilpin.....	10,722	791	1,961.59	9,919	21,887	21,388	-----
Gunnison.....	1,427	952	18.38	9,378	1,604	414,000	500,000
Hinsdale.....	68	44	1.35	1,523	700	25,200	22,000
Lake.....	71,199	29,412	169.07	124,844	37,000	4,504,000	20,223,000
La Plata.....	7,000	339	1,390.26	12,813	-----	63,000	-----
Ouray.....	4,004	939	2,500.06	32,727	8,037	47,975	-----
Saguache.....	110,595	22,238	1,123.46	903,759	4,300,000	4,600,000	-----
San Juan.....	325,855	49,589	15,738.51	815,894	1,746,376	16,569,682	25,427,000
San Miguel.....	27,822	3,346	488.30	135,450	76,034	2,937,431	-----
Summit.....	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Total, 1927.....	712,490 726,969	141,620 146,584	28,532.03 19,800.98	2,559,858 2,286,665	6,988,529 5,256,613	41,043,553 47,203,042	61,807,000 61,937,000

¹ Included with Eagle County.

Mine production of metals from Colorado concentrates in 1928, in terms of recovered metals

BY COUNTIES

	Concentrates	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Boulder.....	690	3,342.17	34,498	3,341	124,169	-----
Clear Creek.....	1,099	446.08	112,695	630	320,667	60,000
Dolores.....	21,098	1,010.50	326,003	791,517	8,597,222	9,203,000
Eagle and Summit.....	11,070	448.96	40,075	1,403	2,814,819	6,330,000
Fremont.....	51	1.02	371	-----	4,000	42,000
Gilpin.....	885	2,037.88	10,715	21,887	73,114	12,000
Gunnison.....	952	18.38	9,378	1,604	414,000	500,000
Hinsdale.....	44	1.35	1,523	700	25,200	22,000
Lake.....	29,412	169.07	124,844	37,000	4,504,000	20,223,000
La Plata.....	339	1,390.26	12,813	-----	63,000	-----
Ouray.....	1,449	6,041.20	43,718	30,988	98,182	-----
Park.....	29	126.19	158	278	4,615	-----
Saguache.....	22,238	1,123.46	903,759	4,300,000	4,600,000	-----
San Juan.....	49,589	15,738.51	815,894	1,746,376	16,569,682	25,427,000
San Miguel.....	19,791	17,167.30	624,157	100,034	6,075,431	-----
Summit.....	(1)	(1)	(1)	(1)	(1)	(1)
Total, 1927.....	158,736 172,569	49,062.03 49,313.26	3,060,601 2,920,211	7,035,758 5,317,814	44,288,101 53,410,373	61,819,000 62,443,000

BY KINDS OF CONCENTRATES

Dry gold.....	2,345	8,089.72	58,872	32,013	170,243	-----
Dry gold and silver.....	17	54.57	2,090	-----	500	-----
Dry silver.....	3,370	185.39	10,470	76,000	122,000	-----
Copper.....	322	1,620.22	7,634	20,473	16,153	-----
Copper-lead.....	39,759	13,685.19	1,495,934	5,561,273	18,733,118	700,000
Lead.....	38,281	22,107.06	1,204,920	566,282	22,228,060	-----
Total to copper and lead plants.....	84,094	45,742.15	2,779,920	6,256,041	41,270,074	2 700,000
Lead-zinc.....	3,812	1,363.86	57,303	120,000	1,232,000	1,200,000
Zinc.....	70,830	1,956.02	223,378	659,717	1,786,027	59,919,000
Total to zinc and lead plants.....	74,642	2 3,319.88	2 280,681	2 779,717	2 3,018,027	2 61,119,000
	158,736	49,062.03	3,060,601	7,035,758	44,288,101	61,819,000

¹ Included with Eagle County.

² Recovered at sulphating plant, Durango, Colo.

³ Recovered in zinc residues.

⁴ Lead recovered in zinc residues and leaded zinc oxide.

⁵ Zinc recovered as metal and zinc in zinc oxide.

Gross metal content of Colorado crude ore shipped to smelters in 1928

Class of ore	Ore		Gross metal content				
			Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Per cent</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Dry gold.....	4,741	5.72	15,411.74	28,754	19,271	203,451	539
Dry gold and silver.....	2,110	2.54	2,236.17	36,546	106,461	56,701	11,047
Dry silver.....	32,849	39.64	465.20	329,036	170,673	2,689,479	110,000
Copper.....	11,983	14.46	769.31	235,581	1,355,904	70,209	965,052
Copper-lead.....	366	.44	315.29	14,292	33,010	115,389	23,355
Lead.....	9,985	12.05	1,014.56	126,097	41,377	3,619,812	150,641
Lead-zinc.....	20,842	25.15	127.08	90,109	1,073	4,803,797	12,053,947
	82,876	100.00	20,339.35	860,415	1,727,769	11,558,838	13,314,581

Mine production of metals from Colorado crude ore shipped to smelters in 1928, in terms of recovered metals

BY COUNTIES

	Ore	Gold	Silver	Copper	Lead	Zinc
	<i>Short tons</i>	<i>Fine ounces</i>	<i>Fine ounces</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Boulder.....	146	100.42	15,039	520	19,624	-----
Chaffee.....	65	5.22	282	-----	21,793	-----
Clear Creek.....	333	182.48	17,036	4,419	82,643	-----
Custer.....	48	1.60	1,395	-----	15,345	-----
Dolores.....	2,271	88.24	27,038	95,497	454,382	89,000
Eagle.....	12,287	779.72	251,706	1,219,202	51,000	-----
Gilpin.....	187	146.75	4,970	8,627	34,817	-----
Gunnison.....	252	120.28	6,316	597	98,569	-----
Hinsdale.....	38	3.00	1,270	910	20,212	-----
Lake.....	47,401	5,689.50	248,131	181,625	5,832,087	9,380,000
La Plata.....	1,118	853.90	11,348	97	-----	-----
Mesa.....	2	-----	29	1,202	-----	-----
Mineral.....	581	10.10	38,993	-----	23,000	-----
Ouray.....	137	1,046.83	2,423	19,748	3,112	-----
Park.....	2,430	10,339.92	8,109	6,305	159,109	-----
Pitkin.....	14,339	2.08	96,764	-----	1,612,311	174,000
San Juan.....	255	76.00	11,424	9,277	124,767	-----
San Miguel.....	662	715.28	32,319	10,862	455,000	-----
Summit.....	324	56.39	4,662	-----	205,851	-----
Total, 1927.....	82,876	20,217.71	779,254	1,558,888	9,213,622	9,643,000
	105,397	10,178.56	740,017	352,767	13,362,184	9,286,000

BY KINDS OF ORE

Dry gold.....	4,741	15,411.74	28,754	13,246	177,947	-----
Dry gold and silver.....	2,110	2,236.17	36,546	74,458	49,612	-----
Dry silver.....	32,849	465.20	329,036	119,360	2,352,939	-----
Copper.....	11,983	769.31	235,581	1,299,636	35,157	-----
Copper-lead.....	366	315.29	14,292	23,116	102,210	-----
Lead.....	9,985	1,014.56	126,097	28,385	3,196,317	-----
Total to copper and lead plants.....	62,034	20,212.27	770,306	1,558,201	5,014,182	-----
Lead-zinc.....	20,842	5.44	8,948	687	3,299,440	9,643,000
Zinc.....	-----	-----	-----	-----	-----	-----
Total to zinc smelters and zinc oxide plants.....	20,842	5.44	8,948	687	3,299,440	9,643,000
	82,876	20,217.71	779,254	1,558,888	9,213,622	9,643,000

¹ Recovered in zinc residues.

² Lead recovered in zinc residues and leaded zinc oxide.

³ Zinc recovered as metal and zinc in leaded zinc oxide.

REVIEW BY COUNTIES AND DISTRICTS

ADAMS COUNTY

Sluice boxes placed below the waste flumes of the Brannan sand and gravel, Carlson gravel, and Gordon sand and gravel washing and screening plants on Clear Creek recovered \$4,146 in gold and 29 ounces of silver in 1928. No estimate can be made of the yardage and gold content of the waste sand handled nor the average gold content of the original gravels, because the sluices could be operated only during the operation of and at the convenience of the screening plants. At times when the plants were in operation the sluice boxes were not in place. Steam shovels and drag-line scrapers were used to dig the deposits, which are both stream and low-lying bench gravels in the flood plain of the creek. During the year more than one set-up was made by the sand and gravel plants, but in this report

the production is credited to three placer operations. For 2 to 3 miles above and below a point at which the extension of Federal Boulevard, north of Denver city limits, crosses Clear Creek 30 sluice-box installations on gravel plant set-ups have been made in the last eight years, all showing colors of fine gold. The first gold recovery in 1922, and for several years afterward the only recovery by these methods, was made by F. D. Goody, who uses a patented sluice box.

In later years other sluice operators have been Edward Manion and M. E. Carlson. Panning and sluicing of these gravels in 1858 and 1859 gave sufficient gold colors to lead the prospector in 1859 up Clear Creek to higher-grade gravels at Golden and Idaho Springs and to surface gold deposits at Black Hawk, thus overcoming the disappointment resulting from the meager returns from Cherry Creek and beginning the first stable settlement of central Colorado.⁴ In 1904 and 1905 a gold dredge working in Jefferson County, several miles above these present-day gravel plants, recovered \$21,000 in gold. Since 1859 much gold has been lost into Clear Creek by the mills of Clear Creek and Gilpin Counties. No study has been made to determine whether these Adams County deposits contain only the original placer gold or whether there is also a redeposit from the gold mill losses. From 1922 to 1928, inclusive, \$15,272 in gold and 113 ounces of silver have been recovered by the sluice boxes below the sand and gravel plants. In 1928 the fineness of gold was 0.804 to 0.868 and that of silver, 0.117 to 0.129.

ALAMOSA COUNTY

A 1,448-pound test lot of gold ore shipped from the Red Eagle prospect, 12 miles from Blanca, assayed 0.73 ounce to the ton. During 1928 the cost of construction and other development at this property, including 50 feet of drifting, aggregated \$8,000.

BOULDER COUNTY

Central district (Jamestown).—Six mines near Jamestown in 1928 produced 762 tons of ore, yielding \$9,608 in gold, 354 ounces of silver, and 11,466 pounds of lead. The lead came from 17 tons of material sent to the Leadville smelter from the Argo and Buckhorn properties and from the Lehman mill (concentrates); the material carried also 4.17 ounces of gold and 225 ounces of silver. The pyritic ore from the Buckhorn was trucked to the Lehman concentration mill, originally designed to handle fluorspar. The pyritic gold concentrates produced were shipped to the Golden Cycle mill at Colorado Springs. Gold ore from the Wano group was shipped direct to the Golden Cycle mill. Small lots of gold ore from the Black Rose and Golden Cross were sold through the Boulder sampler to the Golden Cycle mill. The Central district is also known for its fluorspar deposits, which occur as the gangue of the gold ores and in a large brecciated zone.

Gold Hill district.—From the Gold Hill district in 1928 small lots ranging from less than one-half ton to 83 tons were shipped from 23 individual mining properties or dumps; the shipments aggregated

⁴ Henderson, Chas. W., Mining in Colorado: U. S. Geol. Survey Prof. Paper 138, 1926, pp. 1-8.

283 tons of ore, carrying 396.79 ounces of gold, 4,467 ounces of silver, 261 pounds of copper, and 5,809 pounds of lead. The copper and lead came from 76 tons of smelting ore, which also carried 63.15 ounces of gold and 4,033 ounces of silver. The district gold and silver, except 8.97 ounces of gold and 2 ounces of silver contained in specimen gold bullion sent to the Denver Mint, was contained in 207 tons of ore either purchased by the Boulder sampler, where it was mixed and shipped to the Golden Cycle mill, or shipped direct to the Golden Cycle mill. The more important producers were the American, Betsey Babbit, Goldsmith Maid, Happy Thought, Lottie, Lucky Star, and Morning Glory. All of the ore from the Gold Hill district, except that from the Goldsmith Maid, which was dry silver smelting ore containing 37 ounces of silver, 3.76 per cent of lead (wet assay), and 0.17 ounce of gold to the ton and that from the Morning Glory, which was a lead-silver-gold ore containing 1.17 ounces of gold, 150 ounces of silver, and 6.2 per cent of lead (wet assay) to the ton, was gold ore containing very little silver. Other producing properties were the Atlanta, Big Horn, Black Cloud, California, Fisk dump, Glad Eye dump, Half Moon, Horsfal, Ingram, Plow Boy, Poorman, Richmond, St. Joe, Salina, Steam Power, and Sun and Moon.

Grand Island district (Cardinal, Caribou, Eldora, and Nederland).—All of the ore from the Grand Island district in 1928, except two small lots (each less than one-half ton) of gold ore from the Jack Pot mine near Caribou carrying 1.77 ounces of gold and 19 ounces of silver to the ton, came from the Boulder County mine at Cardinal, operated by the Fairview Mining Co. The mine was closed on October 15, 1928. The Fairview Mining Co. shipped 8 tons of lead-gold-silver smelting ore direct to the Leadville smelter and sent to its own flotation and gravity concentration mill 16,300 tons of dry gold ore, from which was recovered 652 tons of lead-gold-silver concentrates. These concentrates averaged 4.96 ounces of gold, 52.8 ounces of silver, and 10.9 per cent of lead (wet assay). The mill is equipped with 1 Universal 400-ton crusher, 1 Universal 100-ton crusher, 1 Ruth 110-ton rod mill, 2 gravity concentration tables, 4 flotation machines, classifiers, filters, and dryers. The rated capacity is 100 tons in 24 hours, but the daily average treated when in operation in 1928 was 60 tons. The Boulder County vein is reached by a crosscut adit running north from the portal on Coon Trail Creek, near Cardinal. A continuation of the west drift on the Boulder County vein would drain Caribou Hill. Two Fahrenwald flotation units were added to the Potosi mill, built in 1927, at Caribou, but the mill was not operated in 1928. The equipment also includes 1 Gates gyratory crusher, 1 Straub crusher, 60 Straub stamps, 6 Straub-Tyler screens, amalgamating plates, 3 Wilfley tables, and 1 Overstrom table. At the Roseberry-Terror group at Eldora development work (155 shifts) was done and a 75-ton cyanidation and flotation mill was completed.

The Grand Island district also includes the main tungsten deposits of Boulder County, lying north, east, and south of Nederland.

Magnolia district.—Several small lots of gold ore aggregating 9 tons, containing 13.66 ounces of gold and 8 ounces of silver, were mined from 6 properties in the Magnolia district and sold to the Boulder sampler, where the ore was mixed with other purchases and

shipped to the Golden Cycle mill. The ore came from the Franklin, Kansas City, Mountain Lion, Rusty Dime, Senator Hill, and West End, all old properties except the Rusty Dime, which had been located during the year by a prospector sent out by the Boulder County Grubstake Association.

Sugar Loaf district.—Seven mines in the Sugar Loaf district in 1928 produced 2,227 tons of ore, which yielded 576 ounces of gold, 11,041 ounces of silver, 333 pounds of copper, and 2,741 pounds of lead, with a total gross calculated value for the four metals of \$18,573. At the Logan mine (opened by a 600-foot adit) 200 feet of drifts, 50 feet of crosscuts, and 75 feet of raises were driven; 45 tons of silver ore, averaging 233 ounces to the ton, was shipped to the Boulder sampler. The Metals Production Co. employed an average of 13 men on development work throughout the year on the Nancy group and made repairs and additions to the 150-ton flotation mill. The mill was operated for about three months, producing gold-silver concentrates, which were sent to the Golden Cycle mill by the Boulder sampler. The Mountain Plains Co. operated the Wood Mountain amalgamation-gravity concentration-flotation mill (originally built in 1923) intermittently during 1928; gold-silver amalgam and gold-silver concentrates were produced. At the Wood Mountain mine 250 feet of raises, 200 feet of drifts, 50 feet of crosscuts, and 50 feet of winze were driven. The mine has 6,000 feet of openings. Small lots of dry gold ore were sold to the Boulder sampler from the Gladys, Paymaster-Wheelman, Post Boy Tunnel, and Red Signe groups.

Ward district.—Four properties—the Grand View, Newmarket, Star, and Yellow Bird-Elsie Owen groups—in the Ward district in 1928 produced 9 tons of dry gold ore, carrying 20.62 ounces of gold and 65 ounces of silver.

CHAFFEE COUNTY

Chalk Creek district (Romley).—The Mary Murphy mine and mill in the Chalk Creek district remained idle in 1928. Assessment work was done on several prospects in the district. A 5-ton lot of lead-silver-gold ore was shipped from one of the dumps to the Leadville smelter.

Four Mile district (Buena Vista).—Chas. V. Derillo, in 2 months, at the rate of 2 yards a day, sluiced out 5 crude ounces of gold from the Arkansas River bed near Buena Vista. He did not market the gold in 1928.

Granite district.—A 1-ton lot of lead-gold-silver ore was shipped to the Leadville smelter from the Mayflower property, in the Granite district. The suction dredge, upon which work was started in 1927, just below Granite, in the Arkansas River, was not completed for operation in 1928. Gold bullion obtained by sluicing gravels from the Cache Creek placer averaged after melting at the Denver Mint 0.831 fine in gold and 0.163 in silver. Gold bullion similarly obtained from the Saguache placer averaged at the Denver Mint 0.849 fine in gold and 0.145 in silver.

Monarch-Garfield district.—A lessee on the Madonna mine at Garfield shipped 58 tons of lead-silver oxidized ore to the Leadville smelter.

Red Mountain district (Twin Lakes).—A 1-ton lot of gold ore was shipped to the Leadville smelter from the Bowman mine, in the Red Mountain district.

CLEAR CREEK COUNTY

Alice district (Yankee, Lincoln).—The Alice district is 12 miles from Idaho Springs at the head of Fall River. The Caddo 100-ton 20-stamp amalgamation-gravity concentration-flotation mill, built in 1928, was operated for a few days on ore from the Yukon, yielding a small bar of gold bullion. The Yukon is opened by an 1,827-foot adit. In 1928 development work totaled 600 feet of crosscuts and 700 feet of drifts. The equipment of the Caddo mill consists of 1 crusher, 20 McFarlane stamps (1,250 pounds each), 4 copper amalgamating plates, 1 McFarlane ball mill, 2 Wilfley and 2 Deister concentrating tables, and 1 Denver Equipment Co. flotation machine. At the Lombard property a small crew of men worked underground 60 days and extracted 732 tons of ore. The ore was milled intermittently between September 2 and October 14 in the Lombard amalgamation-gravity concentration mill and yielded dry gold-silver concentrates carrying also small quantities of zinc and lead. The Lombard mill is at the portal of a 1-mile adit, and is equipped with 1 crusher, 20 stamps, 1 ball mill, 4 concentrating tables, and 1 flotation machine; the stamps and plates and flotation machine were not used.

Argentine district (Silver Plume).—At the Gold Belt Tunnel group, opened by a 1,600-foot adit, 80 feet of drifting was done in 1928 and 16 tons of lead-[zinc]-silver smelting ore was mined and shipped to the Idaho Springs sampler. The ore carried 139 ounces of silver to the ton. A 7-ton lot of similar ore was shipped from the Hamill group. At the Santiago mine, long idle, the East Argentine adit was cleaned and retimbered, as was the adit level of the Santiago vein, upon which 200 feet of new drifting was done. Santiago level No. 3 was reopened and retimbered and a 50-foot raise put up.

Empire district.—In 1928 five mines in the Empire district produced 3,208 tons of ore, yielding \$10,819 in gold and 183 ounces of silver. The Gold Dirt 100-ton gravity concentration-flotation mill (formerly known as the Rose City No. 2) was operated at part capacity for 220 days in 1928. The equipment consists of 1 Universal crusher (rated capacity, 120 tons in 24 hours), 1 Ruth rod mill, 1 Akins classifier, 2 Plato concentration tables, 2 Ruth flotation machines, 1 Portland filter, and 1 Hendryx thickening tank. The Gold Dirt mine was operated 310 days, during which time 400 feet of drifts with stopes raised therefrom was driven. The main adit is 3,600 feet in length. The ore is an iron pyrite ore carrying gold. The ratio of concentration in 1928 was 13 to 1. The concentrates were shipped to the Golden Cycle mill, at Colorado Springs, and were there treated in the fine-grinding nonroast cyanidation department. Other shipments from the district were small lots of dry gold ore from the Mint mine, sold to the Golden Cycle mill and to the A. V. smelter; dry silver ore from the Mineral Queen, sold to the A. V. smelter; dry silver ore from the Morrison, sold to the Golden Cycle mill; and dry gold ore from the Victor Tunnel property, sold to the A. V. smelter. Some of these lots went through

the Clear Creek Gilpin Ore Co. sampler at Idaho Springs and were there mixed with other lots and distributed to either the Golden Cycle mill or to the A. V. smelter.

Griffith district (Georgetown-Silver Plume).—In 1928 six mines in the Georgetown-Silver Plume district produced 38,150 tons of ore, yielding \$4,199 in gold, 109,347 ounces of silver, 417 pounds of copper, 231,104 pounds of lead, and 60,000 pounds of zinc, with a gross calculated value for the five metals of \$85,291, compared with \$9,565 in 1927 and with \$176,663 in 1926. From July to November, inclusive, a lessee, the Butte Mining Co., treated in the 250-ton Nashotah mill the remainder of the Zero dump, owned by the East Butte Copper Mining Co., of Butte, Mont., and the Corry City dump, of separate ownership. No new underground development was done on the East Butte property, but the Butte Mining Co. reopened the Diamond adit for a distance of 1,500 feet on the East Butte's Dives-Pelican ground and 2,500 feet on Corry City ground. The East Butte Copper Mining Co. in 1925 remodeled the Nashotah, an old mill at Silver Plume, and operated it during 1926. The equipment in 1928 consisted of one 15 by 24 inch crusher, one grizzly, one 16 by 40 inch Colorado Iron Works rolls, one 16 by 36 inch Colorado Iron Works rolls, one 8 by 3 foot Hardinge ball mill, four 45-inch Akins classifiers, one 6-cell Janney flotation machine, used as a cleaner, and two 5-cell Akins flotation machines, used as roughers.

The St. George 60-ton gravity concentration-flotation mill was operated at a daily average rate of 15 tons for 73 days. At a ratio of 6 to 1 the sulphides were recovered as concentrates, carrying 1 ounce of gold, 17.2 ounces of silver, 17 per cent of lead (wet assay), and 17 per cent of zinc to the ton. The mill equipment consists of 1 Blake crusher, 1 Colorado Iron Works ball mill, 1 Akins classifier, 4 Wilfley tables, and 2 Akins flotation machines. At the mine 150 feet of drifts and 50 feet of raises were driven. About 40 tons of lead-zinc-silver-gold ore from the Mineral Chief mine was milled at the St. George mill. From this milling lead-silver-gold concentrates containing some zinc were marketed. Probably much of the zinc was discarded. The Mineral Chief is opened by a 2,000-foot adit. No development work was done at the Mendota-Frostberg group of the Wasatch-Colorado Mining Co., but the 70-ton jig and table concentration mill was operated for a short time on ore from the Antelope mine. Lead-silver-gold and zinc-lead-silver-gold concentrates produced in 1927 from the Mendota were marketed in 1928. This mill is equipped with 3 Universal crushers, 1 Blake crusher, 3 trommels, 2 Walker rolls, 5 Richards pulsating classifiers, 2 Wilfley tables, 2 Card tables, and 6 jigs (four compartments each). A 23-ton lot of lead-[zinc]-silver-gold ore from the Dunkirk mine was shipped to the Leadville smelter. The silver in this shipment assayed 85 ounces to the ton.

Idaho Springs district.—Twenty-five mines in the Idaho Springs district produced 1,452 tons of ore, yielding \$13,181 in gold, 9,429 ounces of silver, 4,424 pounds of copper, and 88,707 pounds of lead, with a total gross calculated value for the four metals of \$24,479, compared with \$61,485 in 1927. The Virginia Mining Co. remodeled the Combination mill at Idaho Springs which, when repairs and additions were completed, consisted of a stamp mill for crushing.

followed by classifiers, a ball mill, flotation machine, and Wilfley tables. Several hundred tons of mixed sulphide ore from the Brighton mine of the Virginia Mining Co. was treated in this reconstructed mill and yielded lead-silver-gold concentrates. The lead concentrates carried much zinc. As a general rule both ore and concentrates of the Idaho Springs district carry zinc in quantity equal to the lead. Lessees on the Bald Eagle, Edgar, and Fulton veins in the Big Five (or North American) adit shipped mixed sulphide smelting ores, chiefly valuable for the gold and silver content, to the Idaho Springs sampler. Lessees on the Lincoln, Queen Elizabeth, and West Gold properties shipped gold ore to the Golden Cycle mill. Other producers of more than 3-ton lots were the Almaden, Crown Point-Virginia, Dawson City, Gold Medal, Kemp mill, Lord Byron, Maud Munroe, P. T., Specie Payment, Treasure Vault, and Trojan. The Clear Creek-Gilpin Ore Sampling Co. continued to operate its sampler at Idaho Springs for the purchase of all lots (from a few pounds to carloads) of ore offered. The sampler serves both Clear Creek and Gilpin Counties.

The Argo mill, at the portal of the 4.16-mile Argo adit, was remodeled in the spring of 1928 to treat Gilpin County ores of the Quartz Hill Holding Co. The mill, as remodeled, has a capacity of 150 tons in 24 hours (50 tons was the daily average treated in 1928). The equipment consists of 1 Universal 24 by 16 inch crusher, 4 copper amalgamating plates, 1 Marcy 6 by 5 foot ball mill, 1 Stearns Rogers 5 by 8 foot ball mill, 2 Dorr classifiers, 5 Card 16-foot concentrating tables, 3 Card 14-foot tables, 1 Overstrom 16-foot table, 2 Minerals Separation 12-cell flotation machines (only one was used), 1 American 4-leaf 6-foot disk filter, 2 thickening tanks, 20 by 12 foot, and 1 thickening tank, 20 by 8 foot.

Montana district (Lawson, Dumont).—Six mines in the Montana district produced 439 tons of ore, yielding \$54 in gold, 7,617 ounces of silver, 208 pounds of copper, and 27,293 pounds of lead, with a total gross calculated value of \$6,123, compared with \$4,830 in 1927. Producing mines were the Jo Reynolds, Mattie Jack, Platts, Red Elephant, Silver Treasure, and White. The Red Elephant flotation mill was used to treat the ore from the Red Elephant group and from the Platts.

Trail Creek district (Lamartine, Freeland).—The Trail Creek district produced 384 tons of ore, yielding \$1,767 in gold, 918 ounces of silver, and 50,276 pounds of lead, with a total gross value of \$5,220, compared with \$6,365 in 1927. Producing mines were the Crazy Girl, Donaldson, Miller Tunnel, New Era-Lone Tree, and Wheatland.

CUSTER COUNTY

Hardscrabble district (Westcliffe, Silver Cliff).—A 6-ton lot of lead-silver ore from the Black Friday, a 1-ton lot of dry silver ore from the Maxine Elliott, and a 40-ton lot of lead-silver ore from the Passiflora were shipped in 1928 from Westcliffe. No new development work was done on the Passiflora.

Oak Creek district (Ilse).—Up to October 1, 1928, 1,865 feet of drifts, 100 feet of winze, and 146 feet of raises were done on the 600 and 700 foot levels of the Terrible mine at Ilse, 23 miles from Florence. From October 1 to November 11, when fire destroyed the shaft

down to the 400-foot level, 377 feet of diamond drilling was done. Reconstruction work was begun. The 300-ton mill, equipped with Harz jigs and Wilfley tables, was idle. The ore milled here from 1922 to 1927 was a low-grade lead ore containing cerussite without gold, silver, or other metals.

Rosita Hills district (Rosita).—A 1-ton lot of dry silver ore was shipped from the Maverick group near Rosita, 10 miles east of Westcliffe. This property is opened by a 175-foot vertical shaft and 1,000 feet of drifts.

DOLORES COUNTY

The total gross calculated value of the mine production of metals in Dolores County in 1928 (nearly all from Rico) was \$1,448,777, compared with \$1,432,554 in 1927, \$990,281 in 1926, \$353,563 in 1925, and \$24,220 in 1924.

Lone Cone district (Dunton).—At the Emma mine, reopened in 1927, 75 feet of shaft was sunk and 200 feet of drifts was driven in 1928. The 50-ton 15-stamp table and flotation mill was operated for a short time and produced a few tons of dry gold and silver concentrates. A 1-ton lot of dry silver ore was shipped to the Durango smelter from the Midnight mine.

Pioneer district (Rico).—The Rico district in 1928 produced 58,443 tons of ore, yielding \$21,585 in gold, 350,653 ounces of silver, 887,014 pounds of copper, 9,051,104 pounds of lead, and 9,292,000 pounds of zinc. Producing mines and mining companies were the Bancroft, Falcon Lead Co., Pelleyre Mining & Milling Co., Rico Argentine Mining Co., Rico Enterprise Mining Co., St. Louis Smelting & Refining Co., and Union Carbonate. The International Smelting Co.'s 250-ton selective flotation custom mill (built in 1925) was operated to July at a daily capacity of 182 tons. The mill treated zinc-lead-copper-silver-gold sulphide ore from all the mines in the district except the Bancroft and the Union Carbonate. After the closing of this local custom mill all of the mines, including the Union Carbonate, shipped their zinc-lead milling ore to the Midvale (Utah) selective flotation mill; the Union Carbonate Co. and the St. Louis Smelting & Refining Co. also shipped to the Combined Metals Co.'s selective flotation mill at Bauer, Utah. In addition, lead-silver ore from the Bancroft, Falcon, Rico Enterprise, and Union Carbonate mines and copper-silver-gold ore from the Rico Argentine were shipped to the Durango lead bullion-copper matte smelter, and zinc-lead-copper-silver-gold ore from the Swan and Wellington groups was shipped to the Amarillo zinc-retort smelter.

The Falcon Lead Mining Co.'s properties include the Nigger Baby Hill or Yellow Jacket group. These mines were idle from June through September. The Pelleyre Mining & Milling Co., a subsidiary of the International Smelting Co. (of Salt Lake City, Utah), did not operate any of its mining property (Syndicate group and others) but cleaned up several carloads of zinc-lead-silver-gold-iron sulphide ore from the Shamrock group dump. The Rico Argentine Co. produced chiefly from the Black Hawk claim. This company did 680 feet of development work. To the end of 1928 the Rico Argentine had paid \$110,706.75 in dividends, of which \$88,565.40 was paid in 1928. The Rico Enterprise Co. produced 4,678 tons of complex

sulphide ore from the Pro Patria group, on Newman Hill. This mine was operated throughout the year. During the year a new compressor was installed. The St. Louis Smelting & Refining Co. operated chiefly the Swan and the Wellington groups and did much development work besides the extraction of ore. At the Union Carbonate mine 800 feet of levels, raises, crosscuts, and inclines were driven. The equipment of the International mill consists of 1 Traylor 12 by 24 inch jaw crusher, 1 Anaconda set of rolls, 1 Hardinge 8 by 3 foot ball mill, 1 Dorr 12-foot classifier, 2 Minerals Separation 14-cell flotation machines, 1 American 6-disk filter, and 2 Dorr thickening tanks.

DOUGLAS COUNTY

Sluicing at the Goody placer, in Newlin Gulch, recovered a small quantity of placer gold of 0.982 $\frac{1}{4}$ fineness.

EAGLE COUNTY

Battle Mountain district (Red Cliff, Gilman).—While continuing development of its large acreage of mining property at Gilman, called the "Eagle mine," the Empire Zinc Co. shipped copper-iron-silver-gold sulphide and iron-silver-gold ore (containing also a low content of copper and lead) to Utah smelters. These ores were needed by Utah smelters for their iron content as flux for the siliceous ores of Utah. No zinc sulphide ore, of which the property has large reserves, was mined in 1928, as plans were ready to abandon the company's magnetic separation plant at Canon City and to build a flotation mill on the property at Gilman, one of the factors being the saving of \$1.90 per ton freight on the low-grade ore from the mine to Canon City. Before abandoning the Canon City mill, however, it was operated for a short time on middlings from previously treated Eagle mine ore. A small shipment of copper-silver-gold ore was shipped from the New California claim to the Leadville smelter. At the 78 claims of the Liberty group, on Turkey Creek, the Liberty Mines Syndicate (Inc.) continued development work; 450 feet of incline winzes and diamond drilling was done. At the Little Chicago group 250 feet of incline shafts and diamond drilling was done.

Holy Cross district.—The old Hunkidory 5-stamp (350 pounds each) amalgamation mill (built in 1896), at the former town of Holy Cross City, at Hunkidory Lake, was repaired in 1928 by the addition of new belts and a pulley wheel, and 5 tons of iron oxidized material from an open cut was milled. The mill is run by a small Pelton wheel. The small quantity of bullion recovered was not marketed.

McCoy district.—On the Colorado River 3 miles below McCoy a small power-operated digging machine, followed by a sluice, recovered a few ounces of gold from the river gravels and sand on property known as the Bjorn placer.

EL PASO COUNTY

The Golden Cycle 1,200-ton roast-amalgamation-cyanidation mill at Colorado Springs, El Paso County, treats all the gold telluride ores, containing 0.1125 ounce gold and above, from the Cripple Creek

district, except the low-grade ores that are treated at the Portland-Independence mill, near Victor, Teller County. The Cresson, Elkton, Empire Lee, Granite, Portland, Queen, and United Gold Mines group supplied the largest part of the tonnage treated at this mill, but a large quantity of low-grade dump material was also moved from the Cripple Creek district. In addition, a supplementary installation of crushers, a ball mill, a Dorr classifier, and tanks were used to treat in an all-sliming cyanidation circuit, without preliminary roasting, gold pyrite ores and concentrates from Leadville, Empire, Idaho Springs, and Russell Gulch; siliceous gold ore from the London mine, west of Alma Junction; siliceous silver ores from Creede; and high-grade specimen gold ore from Summitville. The Golden Cycle mill is operated by electricity developed at the mill by steam turbine. Coal for roasting the ore and for firing the boilers comes from the Pikes Peak mine just north of Colorado Springs. This mill has been operated since 1907, and a sand dump of several million tons containing a small quantity of gold has been built up on ground surrounding the mill. Experiments by the United States Bureau of Mines have shown that this tailings pile also contains potassium silicates. For description of the mill, see Teller County (p. 861).

FREMONT COUNTY

Canon City-Florence mills and smelters.—The Empire Zinc Co.'s Canon City magnetic separation mill has operated almost continuously since 1902 on zinc-lead-iron-silver-gold sulphide ores, at first chiefly from Leadville, Lake County, but more recently only from the company's Eagle mine at Gilman, Eagle County; after October, 1927, however, it received no new shipments from the Eagle mine. For a few months in 1928 it was operated on middlings stored during the last several years from the treatment of Eagle mine ore. The Empire Zinc Co.'s Canon City zinc oxide plant was operated continuously in 1928 on zinc concentrates from the company's flotation mill at Hanover, N. Mex., and on a small tonnage of custom zinc carbonate ore from Leadville. The St. Louis Smelting & Refining Co.'s matting, fuming, and zinc oxide plant at Florence (under the name of the River Smelting & Refining Co.), on the site of the old Rocky Mountain smelter, was idle in 1928.

Cotopaxi district.—Several cars of zinc-lead-silver-gold sulphide ore from the Cotopaxi mine, 1 mile north of Cotopaxi, were shipped to the custom selective flotation mill at Bauer, Utah.

GARFIELD COUNTY

Newcastle district.—Development work was done at the Gray Eagle property near Newcastle.

Rifle Creek district (Rifle).—No ore was shipped in 1928 (several cars were shipped in 1927) from the Grand View-Lead King group zinc-lead-gold-silver prospect on Rifle Creek. The prospect is in limestone formations, near Vanadium Ranch, 15 miles from Rifle. Development work, consisting of 167 feet of adits, 78 feet of drifts, and a 94-foot winze, in addition to the building of roads and the excavation for a mill, was done throughout the year, and the operators report 2,500 tons of ore on the dumps. Assessment

work was done on 12 claims and on one tunnel site claim. A 10-stamp mill was purchased and part of the equipment moved to the site before deep snow stopped the moving of machinery and material. The proposed mill is to have a capacity of 50 tons in 24 hours. At the Rousseau-Lacy group, whose outcrops of ore are of the same character as those of the Grand View-Lead King, 50 feet of development work was done between February 5 and April 5. In the same district, said to be separated from the zinc-lead deposits by a fault which has left younger geological formations exposed, is the vanadium mine of the United States Vanadium Corporation, a subsidiary of the Union Carbide & Carbon Co. This company has a 110 to 140 ton reduction plant at Rifle, on the Denver & Rio Grande Western Railroad; the plant operated steadily during the year. The ore is hauled from the mine to the mill by gasoline-propelled trucks. The process at the mill includes roasting, leaching, and precipitation of vanadium oxide from a relatively low-grade ore consisting of sandstone impregnated with vanadium minerals.

GILPIN COUNTY

In 1928 Gilpin County lode mines produced 13,180 tons of ore, yielding \$60,331 in gold, 17,383 ounces of silver, 30,514 pounds of copper, 107,931 pounds of lead, and 12,000 pounds of zinc, with a gross calculated value of \$81,886, compared with \$39,696 in 1927. Of the ore mined, 13,000 tons classified as dry ore, contained also most of the silver, copper, and lead, and all the zinc recovered. Placer mines in the Black Hawk and Rollinsville districts recovered 92.83 ounces of gold and 17 ounces of silver. Fineness of the placer gold-silver bullion ranged from 0.761 $\frac{1}{4}$ gold and 0.170 $\frac{1}{2}$ silver to 0.786 $\frac{3}{4}$ gold and 0.181 silver and to 0.869 $\frac{3}{4}$ gold and 0.127 silver.

Southern districts (Black Hawk, Central City, Nevadaville, Russell Gulch).—In 1928 the lode mines of the combined southern districts of Gilpin County produced 12,526 tons of ore, yielding \$59,552 in gold, 17,371 ounces of silver, 30,306 pounds of copper, 107,931 pounds of lead, and 12,000 pounds of zinc, with a gross calculated value of \$81,070, compared with \$35,969 in 1927. The principal producing mines were the Concrete, Kansas-Ophir-Phoenix, and Pozo groups operated from the Argo 4.16-mile adit, whose portal is at Idaho Springs; here, also, is the Argo mill, which was rebuilt and remodeled in the spring of 1928 to a 150-ton amalgamation-flotation mill by the Argo Ore Mill (Inc.) for the treatment of ore from the above-mentioned mines of the Quartz Hill Holding Co. For description of the Argo mill see Idaho Springs district, Clear Creek County, p. 837. The Kansas-Ophir-Phoenix group was closed about 1902; recent efforts of the Quartz Hill Holding Co. have been turned toward unwatering the property by raises from laterals off the Argo adit. The company was successful in 1927 in making the first connection and followed that success in 1928 with other raises, so that part of the old underground workings were open for development and extraction of ore. Of the other producers in the southern area of Gilpin County, the principal ones were the Coaley, Champion, Cousin Jack, Gold Cup-Bullion, Lucky No. 2, Morning Star-Arizona, and Pewabic. The dry gold ore of the Gold Cup-Bullion

group was treated at a mill built in 1928 in Chase Gulch. The equipment of the mill consists of 1 Universal crusher, 1 amalgamating plate, 1 Allis Chalmers roller mill, and 2 Wilfley tables. The mill operated for a short time in 1928 and produced gold amalgam and lead-silver-gold and zinc-lead-silver-gold concentrates. The Pewabic gold ore was shipped direct to the Golden Cycle mill at Colorado Springs.

Northern districts.—A small lot of dry gold ore was sold to the Idaho Springs sampler from the Cornucopia property on Silver Creek. The Smuggler 25-ton 10-stamp amalgamation-table concentration mill was operated two months on dry gold pyritic ore from the Smuggler mine, 2 miles from Rollinsville. The gold amalgam recovered on the plates was sold to the Denver Mint and the gold concentrates to the Golden Cycle mill. After this milling operation the property was idle for nine months, but on December 1 the steam plant was prepared for operation and on December 30 unwatering was started. The property is opened by a 2,130-foot adit, 300 feet of winzes, 3,800 feet of drifts, and several 30-foot raises.

GRAND COUNTY

No production of metals was made in Grand County in 1928.

Elk Mountain district (Hot Sulphur Springs).—On the Elk Mountain claims, 4 miles northwest of Hot Sulphur Springs, over 3,000 feet of adits has been driven. No work was done in 1928.

La Plata (Jones Pass) district (Empire).—All work in 1928 on the Helping Hand-Ready Cash group, a producer in the past of small lots of high-grade silver ore, was confined to driving an adit for drainage. At the end of 1928 the total length of this adit was 75 feet.

Monarch district.—No work was done at the Monarch copper prospects, 12 miles east of Granby, near the Boulder County line.

St. Louis Lake district.—Assessment work was done in 1928 on the Mt. Vasquez Mines Co.'s property near St. Louis Lake at the head of St. Louis Creek.

Williams Fork district.—No work was done at the Bobtail group at the head of Williams Fork.

Wolverine district.—No work was done at the Wolverine group of silver-lead claims in the northeastern corner of the county, near the Jackson County line, 12 miles north of Grand Lake.

GUNNISON COUNTY

Domingo (Goose Creek, White Earth) district (Madera, Powderhorn, Spencer, Vulcan).—Assessment work was done in 1928 on the Anaconda group in sec. 9, T. 47 N., R. 2 W., in the White Earth district and on the Good Friday group, 5 miles east of Madera station, in the Goose Creek district. The Good Hope-Mammoth Chimney-Vulcan group at Vulcan, idle since 1924, was under option in 1928 to the Vulcan Consolidated Mines Corporation, which unwatered the 700-foot shaft and sampled. Development work was done at the Old Lott property between Powderhorn and Spencer.

Elk Mountains district (Crested Butte).—A car of zinc-lead-copper-silver-gold sulphide ore was shipped in 1928 to Midvale,

Utah, from the old Eureka mine on Treasury Mountain, 17 miles north of Anthracite station, near Crested Butte; a car of similar ore was shipped to Midvale from the Van Endert prospect.

Galena Mountain district.—Assessment work was done at the Setz prospects (the Brooklyn and Harper groups) on Galena Mountain, near Schofield Pass, at the head of Rock Creek. Some development work was done in 1928 at the 640 acres of mineral claims on Galena Mountain patented in 1927 by the Puritan Mining Co.

Gold Brick district (Ohio).—At the Carter Mines Co.'s property 800 feet of drifting and raising was done in 1928 and the 20-stamp amalgamation-gravity concentration-flotation mill, operated for a short time, yielded gold-silver bullion which, after melting at the Denver Mint, had a gold fineness of 0.598 $\frac{3}{4}$ and a silver fineness of 0.385 $\frac{3}{4}$; one car of lead-silver-gold smelting ore also was shipped from the Carter mine to the Leadville smelter. A car of lead-silver-gold smelting ore was also shipped from the Raymond property to the Leadville smelter.

Quartz Creek district (Pitkin).—A small lot of lead-silver-gold ore was shipped from the Mountain Boy claim to the Leadville smelter. The Roosevelt adit was driven 510 feet in 1928, making it 4,700 feet long.

Rock Creek district (Marble).—No development work was done in the lower part of Rock Creek in 1928.

Spring Gulch district.—The Doctor mine at the head of Spring Gulch was idle in 1928. Lead carbonate ores were shipped from this mine many years ago and zinc carbonate ores were shipped from 1915 to 1920, inclusive.

Taylor Park district.—During the nine months of operation by lessees several cars of lead-silver-gold oxidized ore were shipped to the Leadville smelter from the Independent Star group on Italian Mountain. The property is opened by two vertical shafts, each 300 feet deep. The old Enterprise mine at the head of Taylor Park, on the east side of Taylor River on Tellurium Creek, was reopened in 1928.

Tin Cup district.—Under the advice of a geologist development was continued part of the year at the old Gold Cup adit in an attempt to find ore in a block faulted from the old ore body.

Tomichi district (Whitepine).—Over 1,000 tons of zinc-lead-copper-silver-gold milling ore was shipped from the Akron group to the Midvale (Utah) custom selective flotation mill.

HINSDALE COUNTY

Galena district (Lake City).—A total of 106 tons of zinc-lead-copper-silver-gold ore was shipped from Lake City in 1928 either to the Midvale (Utah) custom selective flotation mill or to the Leadville (Colo.) smelter. Producing mines were the Big Casino, Capitol City, Gnome, Ocean Wave, and Silver Dollar.

At the Empire-Highland Chief group a total of 723 feet of adit and drifts was run and new machinery was being installed throughout the old mill. A new aerial tram 3,700 feet long was erected. The new flow sheet of the mill is as follows: Crush to 1 $\frac{1}{4}$ inch, thence to ball mill, to Dorr classifiers, to Minerals Separation flotation machines, to Dorr thickeners, and American filter.

JACKSON COUNTY

At the Wolverine property near Pearl, from which copper ore was shipped in 1916 and 1917, development work was done from July 1 to December 31; the property is opened by a 285-foot shaft, and is equipped with a 50-ton gravity concentration mill. At the Village Belle property on Copper Ridge, $3\frac{1}{2}$ miles from North Gate, annual assessment work was done in 1928; the property is opened by a 300-foot shaft and 600 feet of drifts.

JEFFERSON COUNTY

No work was done at the Baxter Gap or at the Malachite property between Bear Creek and Mount Vernon Canyon.

LAKE COUNTY

Lake County in 1928 produced 121,415 tons of ore, yielding gold, silver, copper, lead, and zinc, having a gross calculated value of \$2,903,122, compared with 141,075 tons of ore and \$2,874,116 in 1927 and with 215,315 tons of ore and \$4,104,615 in 1926. Lake County also produced 321,448 tons of molybdenum sulphide ore in 1928 and shipped 18,516 long tons of ferruginous manganese ore to steel mills.

LEADVILLE DISTRICT ⁵

GENERAL FEATURES

In 1928 the metal production of Lake County, except molybdenum, and a 1-ton lot of dry gold ore from the Brick Pomeroy property, near Twin Lakes, came from the Leadville district.

Classification of Leadville ores in 1928, in terms of original content

	Ore		Original analysis							
	Per-cent-age	Short tons	Gold	Silver	Copper (wet assay)	Lead (wet assay)	Zinc	Silica	Iron	Man-ga-nese
Sulphide:			<i>Ounces per ton</i>	<i>Ounces per ton</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Siliceous (carrying sulphides).....	5	5, 613	1.068	9.82	1.32	0.73	(?)	(?)	(?)	-----
Iron pyrites.....	2	2, 776	.059	34.01	.72	3.82	(?)	(?)	(?)	-----
Lead.....		197	.169	2.26		6.78	(?)	(?)	(?)	-----
Copper (excess silica).....		157	.197	24.08	7.34	(?)	(?)	(?)	(?)	-----
Zinc-iron-lead.....	75	91, 404	.006	4.33	.16	7.23	24.42	(?)	(?)	-----
	82	100, 147	-----	-----	-----	-----	-----	-----	-----	-----
Oxide (including low-sulphur ores):										
Siliceous gold.....	1	1, 134	1.185	9.30	.77	2.61	(?)	64.5	15.0	-----
Siliceous silver (including old slags).....	12	13, 961	-----	3.61	-----	3.47	(?)	32.1	27.5	-----
Lead (iron excess).....	3	3, 668	.037	5.79	.19	13.22	(?)	21.2	30.5	-----
Lead (silica excess).....	2	2, 359	.201	7.43		15.31	(?)	40.2	18.9	-----
Lead-copper (silica excess).....		92	1.749	33.27	4.52	10.68	(?)	41.0	17.9	-----
Iron-manganese-silver flux.....		54	.002	27.94	-----	4.87	(?)	13.9	28.0	10.9
	18	21, 268	-----	-----	-----	-----	-----	-----	-----	-----
Metal (sulphide and oxide).....	(a)	(a)	(a)	(a)	-----	-----	-----	-----	-----	-----
	100	121, 415	-----	-----	-----	-----	-----	-----	-----	-----

^a Specimen gold of less than one-half ton (actually about 5,350 ounces) contained 3,464.20 ounces of gold and 825 ounces of silver.

^b For geology, history, and production see Emmons, S. F., Irving, J. D., and Loughlin, G. F., *Geology and Ore Deposits of the Leadville Mining District, Colo.*: U. S. Geol. Survey Prof. Paper 148, 1927, 368 pp.

The A. V. lead bullion-lead copper matte smelter of the American Smelting & Refining Co., formerly equipped with 8 furnaces (only 3 now in working order) ran only 1 furnace in 1928. All the ores and concentrates treated in 1928 came from Colorado mines. As has been the situation for several years, this plant has had to depend in part on slag from old smelter dumps carrying a little silver and lead. The quantity of this slag used in 1928—only about 14,000 tons—was less than in 1927 and 1926 and came from the American and Bi-Metallic slag dumps. The Western Zinc Oxide Co.'s Wetherill grate furnaces continued idle; this plant in the past purchased zinc carbonate ore as low as 14 per cent zinc and made a leaded-zinc oxide for the rubber trade. The Colorado Zinc-Lead Co.'s 350-ton selective flotation mill handled a tonnage equivalent to 194 tons daily for 365 days. This mill in 1928 handled exclusively zinc-lead-copper-silver-gold-iron sulphide ore from the Leadville Deep Mines Co. The average assay of ore sent to mill was as follows: Gold, 0.006 ounce per ton; silver, 4.43 ounces per ton; copper 0.2 per cent wet assay; lead 6.08 per cent wet assay; and zinc 23.08 per cent. The equipment of this selective flotation mill on February 27, 1929, was as follows: 1 Blake 15 by 30 inch crusher, 1 Symons cone 3-foot crusher, 1 Traylor FB 2 Vibrator screen, 1 Stearns Rogers 6 by 12 foot rod mill, 1 Colorado Iron Works 5 by 9 foot rod mill, 1 Ruth 4 by 9 foot rod mill, 1 Dorr 8-foot drag classifier, 1 Akins 5-foot classifier, 3 Deister concentrating tables, 3 Minerals Separation 12-cell flotation machines, 1 American filter, and 2 Dorr thickening tanks. Zinc concentrates produced in 1928 averaged 52.96 per cent of zinc, 2.52 per cent of lead (wet assay), 3.95 ounces of silver, and 0.012 ounce of gold to the ton. Lead concentrates averaged 9.8 per cent of zinc, 39 per cent of lead (wet assay), 18 ounces of silver, and 0.025 ounce of gold to the ton. The zinc concentrates were shipped to the Henryetta (Okla.) and the Amarillo (Tex.) zinc retort plants, to the Blackwell zinc retort plant, to the National Co.'s Bartlesville zinc retort plant, and to the Anaconda Copper Co.'s electrolytic zinc plant, at Anaconda, Mont. The lead concentrates went to the A. V. smelter.

As usual, some of the ores mined at Leadville were shipped for treatment elsewhere. Specimen gold went to the Denver Mint; pyritic gold ores were shipped to the nonroast department of the Golden Cycle cyanidation mill at Colorado Springs; copper-silver-gold sulphide ore to Garfield, Utah; zinc carbonate ores to Canon City, Colo.; zinc-lead-silver sulphide ores to the pigment plant at Coffeyville, Kans.; and zinc-lead-silver-gold sulphide ores to the custom selective flotation plants at Bauer, Midvale, and Tooele, Utah.

MINES REVIEW

The Leadville Deep Mines Co., an operating, leasing, and unwatering enterprise, continued to extract ore and develop a consolidated group of mines on Carbonate Hill and in Graham Park, consisting of the company's Greenback claim and of the holdings of the Iron Silver Mining Co., the Western Mining Co., the Allegheny Mining Co., the Adams Mining Co., the Empire Zinc Co., and the Mikado Lease. That part of this group opened for extraction of ore yielded the bulk of the zinc-lead-silver-gold-iron sulphide and silver-gold-copper-lead-iron (called dry silver ore) sulphide ore of the district in 1928.

Production in 1928 was from the Brookland, Clontarf, Cyclops, Emmet, Gonabrod, Greenback, Hunkadori, Mahala, Moyamensing, and Venus claims. Pumping, hoisting, and other operations are centered at two vertical shafts 1,357 and 1,390 feet deep. The details of the unwatering of this area are described in the reports of this series for 1925 and 1926. In 1928 development work totaled 6,391 feet. In addition to supplying the ore to the Colorado Zinc-Lead Co.'s mill, the Leadville Deep Mines Co. shipped a relatively large tonnage of zinc-lead-[silver] sulphide ore to the leaded-zinc oxide plant of the Ozark Smelting & Mining Co., of Coffeyville, Kans.

Other producers were the Ibex group, from which lessees shipped dry gold-[silver-lead-copper] highly siliceous oxidized ore and dry gold and silver (containing also a low content of lead and copper) sulphide ore to the A. V. smelter, copper-silver-gold sulphide ore to the Garfield smelter, Utah, zinc-lead-silver-gold sulphide milling ore to selective flotation mills at Bauer, Utah, dry gold-[silver] sulphide ore to the Golden Cycle mill, and specimen gold to the Denver Mint; the Golden Eagle, which shipped dry gold sulphide ore to the A. V. smelter, dry silver-[gold-lead-copper] sulphide ore to the A. V. smelter, copper-silver-gold sulphide ore to the Garfield smelter, zinc-lead-silver-gold sulphide milling ore to selective flotation mills at Bauer and Tooele, Utah, dry gold-[silver] sulphide ore to the Golden Cycle mill, and specimen gold to the Denver Mint; the Luema, which shipped lead-silver-gold oxidized ore, containing silica in excess of iron, and dry silver-[gold-lead-copper] sulphide ore to the A. V. smelter; the Iron-Silver, which shipped lead-silver-gold oxidized ore containing iron in excess of silica to the A. V. smelter, and iron-manganese-silver ore to the steel mill at Pueblo; the Maid of Erin-Henriett, which shipped lead-silver oxidized smelting ore containing an excess of iron over silica to the A. V. smelter, zinc-lead-silver-gold sulphide ore to Bauer, Utah, and zinc-lead-[silver] sulphide ore to the pigment plant at Coffeyville, Kans.; the Resurrection, which shipped lead-silver-gold oxidized ore containing silica and iron in equal quantities to the A. V. smelter; and the Dolly B., Famous, and Polaris, which shipped lead-silver-gold oxidized ore containing iron in excess of silica to the A. V. smelter. Other producers of lead-silver-gold oxidized ore containing silica in excess of iron were the Bessie Wilgus, Columbus, Highland Chief, Lilian, Mosquito, New Monarch, Penrose, and Sedalia. Other producers of lead-silver-gold oxidized ore containing iron in excess of silica were the Adelaide, Franklin, and Star group. From the Star group was also shipped iron-manganese-[silver] oxidized ore to the steel mill at Pueblo. The Fanny Rawlings shipped dry silver-[gold-lead-copper] iron sulphide smelting ore. From the St. Louis Tunnel group was shipped lead-copper-silver-gold oxidized smelting ore with excess of silica over iron. Dry gold sulphide ore was shipped from the Little Vinnie and from the President to the Golden Cycle mill. Zinc-lead-silver-gold sulphide ore was shipped from the lease on the Colonel Sellers to the zinc-lead pigment plant at Coffeyville, Kans.

At the Adelaide mine, opened by a 200-foot inclined shaft and 300 feet of drifts, \$3,000 was spent on development work. Development at the Star group was confined to search and extraction of iron-manganese-[silver] oxidized ore. The Colonel Sellers workings are reached by a 150-foot drift from the breast of the Yak adit. No

new development work was done at the Fanny Rawlings. At the Little Vinnie-Golden Eagle 500 feet of drifts were driven. At the Maid of Erin-Henriett the Evans Wallower Lead Co., lessee, drove 1,570 feet of development openings. The lessee on the Highland Mary drove 300 feet of drifts and upraised 30 feet. Lessees on the Iron Silver Mining Co.'s Iron Hill group drove 630 feet of drifts, 81 feet of raises, and 45 feet of shaft. The lessee on the Lilian upraised 100 feet and drove 100 feet of drifts. At the Luema 300 feet of drifts and 100 feet of raises were driven. From the Yak 4-mile custom drainage and transportation adit 1,000 feet of development work was done on holdings of the Yak mines of the American Smelting & Refining Co. No work was done at the Canterbury drainage adit.

OTHER DISTRICTS

Alicante, Colorado Gulch, Lackawanna Gulch, Red Mountain, St. Kevin, and Sugar Loaf districts (west of Leadville).—The only production from the mining districts west of Leadville and the Arkansas River in 1928 was a small shipment of dry gold ore from the Brick Pomeroy property near Twin Lakes.

Arkansas River and tributaries placer districts.—No placer gold was recovered from gravels in Lake County in 1928, although some was recovered just across the line in Chaffee County.

Tenmile (Climax, Fremont Pass) district.—The Climax Molybdenum Co.'s mill at Climax, on Fremont Pass (at an altitude of 11,320 feet), in 1928 produced 2,882 tons of molybdenite concentrates, containing 2,957,845 pounds of elemental molybdenum, from 321,448 tons of ore milled. The mill is on the Colorado & Southern narrow-gage Denver to Leadville branch, 12 miles from Leadville. A 1-mile tram connects the mill and the crusher plant at the portal of the White adit. The mine is about halfway up the west slope of Bartlett Mountain, the highest point of which is 13,554 feet. That part of the ore body worked in 1928 is represented by three stopes 400 feet long, 50 feet wide, and 200 feet high; the two outside stopes are separated from the middle stope by 40-foot pillars, all above the White adit, the portal of which is 12,000 feet. Mining is by the shrinkage stope system and caving.⁶ Development in 1928 totaled 2,078 feet of drifts and 4,912 feet of raises. Only one diamond drill was kept at work continuously, but adjacent to the working stopes diamond-drill holes have determined that there is much ore above the White adit and that it also extends about 465 feet below the White adit. The shape of this ore body, as limited by commercial considerations, resembles a one-fourth to one-half segment of an opened umbrella, the cloth of which represents a thickness of 200 to 500 feet. Other drilling seems to indicate that the entire mineralization is represented by the covering of the whole umbrella, held upright over the head. It also appears that some of the ore at the bottom may be represented by the ribs which project beyond the umbrella covering. In the center of the space covered by the umbrella is a barren or nearly barren silicified zone, and beyond the covering the mineralization blends into an outer covering of less mineralized and

⁶ Coulter, William J., Mining Molybdenum ore at Climax, Colo.: Eng. and Min. Jour., vol. 127, No. 10, Mar. 9, 1929, pp. 394-400.

less silicified pre-Cambrian granite. The granite was brecciated before mineralization and silicification. On the eastern side of this half ball of ore is a fault; it seems to be premineral and therefore disturbs the ore little, if, in fact, it even reaches the commercially determined limits of the ore body. Some distance westward beyond what is presumed to be the west limits of this half ball is the Mosquito Fault, running in a general north-south direction. A new adit is being considered; it will start near the mill, run in a general easterly direction, cut the sedimentary deposits that lie to the west of the Mosquito Fault, thence through the fault into the pre-Cambrian granite, probably just north of any mineralization. This adit will be in sedimentaries about 2,200 feet and will then have to be extended 1,000 feet more to get completely under the north end of the diamond-drilled ore of the eastern half of the umbrella. No safe conjecture can be made as to what it will strike for the first 500 feet in the granite.

As of March 18, 1929, the equipment of the 1,000-ton selective flotation mill (892 tons daily average for 360 days in 1928) was as follows: A set of 20 by 54 inch Garfield rolls, a 24 by 36 inch Allis Chalmers Superior jaw crusher, and a 4-foot Symons cone crusher, which crush the ore at the mine to one-half inch. At the mill are three 6 by 6 foot and two 6 by 10 foot Allis Chalmers ball mills, 6 Model C 150-ton Dorr classifiers, 14 Callow flotation machines, 1 Oliver 4-foot filter, 8 steam-heated pans 6 by 10 foot for drying molybdenite concentrates, and one 9 by 10 foot Dorr thickening tank. Since the reopening of the mine in August, 1924 (after an idleness from the first operation from 1918 to 1920), milling has been continuous and the daily average, at first 150 tons, has gradually increased. The milling practice has been developed until it has become not only efficient but simple.⁷

The production at Climax from 1924 to 1928 has been as follows:

Molybdenum production at Climax mill, Colo., 1924-1928

Year	Elemental molybdenum
	<i>Pounds</i>
1924 (5 months)-----	156, 935
1925-----	821, 757
1926-----	1, 057, 367
1927-----	1, 858, 228
1928-----	2, 957, 845
Total-----	6, 852, 132

LA PLATA COUNTY

La Plata County includes the California (La Plata), Cave Basin, Needle Mountain, and Oro Fino mining districts. The American Smelting & Refining Co.'s smelter at Durango, which makes lead bullion and leady copper matte, is equipped with one blast furnace and handles mainly concentrates, but also whatever ore is offered from Dolores, La Plata, Ouray, San Juan, and San Miguel Coun-

⁷ Coulter, W. J., *Crushing and Concentrating Molybdenum Ore at Climax, Colo.*: Eng. and Min. Jour., vol. 127, No. 12, Mar. 23, 1929, pp. 476-480.

ties, with occasional lots of ore from Mineral, Lake, and Eagle Counties. The Read-Coolbaugh sulphating plant is also at the smelter; it was built in 1923 to remove the zinc from the concentrates, as nearly all of the San Juan region concentrates for years have carried enough zinc to constitute 10 per cent or more of the smelter charge, with all the consequent losses that zinc causes in smelting. The zinc sulphate produced has had a sale in recent years as a flotation reagent.

Two mines, the May Day and the Gold King, and six prospects produced 8,120 tons of ore, yielding \$17,433 in gold, 24,193 ounces of silver, 97 pounds of copper, and 63,000 pounds of lead, with a total gross calculated value for the four metals of \$65,254, compared with \$28,156 in 1927.

California (or La Plata) district (Hesperus, La Plata).—The May Day, a well-known former producer, was reopened in 1927; the principal work that year was for ventilation, including 567 feet of incline shaft and 200 feet of drifts. Several hundred tons of gold-silver ore was shipped. In 1928 no development was done, but 1,000 tons of dry gold-silver oxidized ore was shipped. At the Gold King mine in 1928 operations of the La Plata Mines Co. consisted of development of the mine and the remodeling and testing of the La Plata mill (originally built in 1908 and partly remodeled in 1927). Development work consisted of 646 feet of drifts, 254 feet of raises, and 115 feet of winzes. At the end of 1928 the property was opened by a 589-foot adit, 1,820 feet of drifts, 350 feet of raises, and 115 feet of winzes. The mill was run for 70 days at an average rate of 100 tons a day. The ore contains nearly nine times as much silver, by weight, as gold, and sulphides of iron, lead, zinc, antimony, arsenic, and bismuth; the value of the concentrates, however, was four times as great in gold as in silver, and the lead settlement was small. The concentrates carried 10 per cent of lead and 7 per cent of zinc. As of January 19, 1929, the mill equipment was as follows: 1 crusher, 50 Allis Chalmers (1,000-pound) stamps, 1 Colorado Iron Works 5 by 5 foot ball mill, 1 Denver Engineering Works 6 by 8 foot tube mill, 2 Akins 36 by 45 inch classifiers, 6 No. 5 Wilfley tables, 3 Denver Sub-A 6-cell flotation machines, 1 diaphragm flotation machine, 1 scavenger flotation machine, 1 Portland 2½-foot filter, and 1 Dorr 8-foot thickening tank. A 1-ton lot of dry silver ore from the Mountain Meadow and a 2-ton lot of dry silver-[gold] ore from the Sadie were shipped to the Durango smelter. A 2-ton lot of ore assaying 7 ounces of gold and 7 ounces of silver to the ton was shipped from the Stafford prospect to the Golden Cycle mill. Two small lots of specimen gold from the district were sent to the Denver Mint. Assessment and development work was done on the Eagle Pass group, on 11 claims of the Jumbo group, on the Idaho, and on the Diamond group.

Mount Runlett (or Cave Basin) district (20 miles north of Bayfield).—A 3-ton lot of ore assaying 33 ounces of silver to the ton was shipped from the Silver Reef prospect.

Needle Mountain district.—Assessment work was done on several claims in the Needle Mountain district.

Oro Fino district.—Assessment work was done on the Neglected and Oro Fino groups.

LARIMER COUNTY

Manhattan district.—In section 31, T. 9 N., R. 73 W., 33 miles west of Roberts spur, on the Colorado & Southern Railway, the Cash Gold Mining Co. in 1928 drove a 75-foot drift on one claim and did assessment work on other claims.

MESA COUNTY

Sinbad district.—A 2-ton lot of copper-silver ore was shipped from the Precipice prospect, 65 miles southwest of Whitewater. This property is opened by a 660-foot adit, an 80-foot shaft, and 20 feet of drifts.

MINERAL COUNTY

Creede district.—Six mines in the Creede district in 1928 shipped 4,021 tons of dry silver ore containing 23.71 ounces of gold, 229,847 ounces of silver, and 25,517 pounds of lead; 3,440 tons of ore went to the Golden Cycle mill and 581 tons went to the Leadville and Durango smelters. Producing mines were the Amethyst, Commodore, Equity, Happy Thought, Mollie S., and New York-Last Chance-Volunteer group. The lessee on the Amethyst drove 200 feet of crosscuts, 50 feet of winze, and 250 feet of drifts. The lessee on the Commodore drove 650 feet of drifts, 100 feet of crosscuts, and 140 feet of raises. The lessee on the New York-Last Chance-Volunteer drove 240 feet of drifts, 110 feet of crosscuts, and 70 feet of raises. At the Equity, 7½ miles from Creede, no development work was done but a 20-ton flotation plant and an electric power plant were built. Assessment and development work was done at the Monon—in all 200 feet.

MOFFAT COUNTY

Four Mile Creek district (Baggs, Wyo.).—Two small sluicing operations on Four Mile Creek, Moffat County, yielded 11.22 crude ounces of gold-silver bullion, which after melting at the Denver Mint weighed 10.07 ounces. The fineness of the gold bullion ranged from 0.942 to 0.949 gold and from 0.055 to 0.049 silver. The content of the two lots was 9.53 ounces of gold and a little silver.

MONTROSE COUNTY

Small sluicing operations on bench gravels below Naturita, Montrose County, soon indicated that no profitable recovery was being made; consequently, the gravel bank was abandoned, and no other work was attempted in 1928.

OURAY COUNTY

Red Mountain district.—Two cars of copper-silver-gold-iron sulphide ore from the Laura Dunmore group and a 3-ton lot of nearly similar ore from the Marigold prospect, which was shipped to the International copper smelter at Tooele, Utah, constituted the entire production from the Red Mountain district in 1928. At the Laura Dunmore a shaft house was built, a compressor and air hoist were

installed, and a 65-foot shaft was sunk, from which 20 feet of drift was run. The Marigold is opened by a 27-foot adit. No development was done at the Barstow mine. Six men underground and two on the surface worked 45 days at the Beaver-Belfast group, which has adits and drifts totaling 900 feet. Some development work was done in the Guston mine through the Joker adit; the adit is part of the Genessee-Vanderbilt-Yankee Girl group workings, upon which no work was done.

Sneffels district.—The Camp Bird Leasing Co. operated 366 days and drove 220 feet of raises in its leased ground in the upper workings of the famous Camp Bird mine. The company ran its 50-ton amalgamation-concentration mill 245 days, and also shipped a few cars of dry gold ore to the Leadville smelter and to the Golden Cycle mill. The Camp Bird Lease mill was completed in 1927 in Imogene Basin, at the mouth of the upper adit. The product from the mill was gold-silver bullion which after melting had a gold fineness of 0.753 and a silver fineness of 0.233 and gold-silver (with small content of copper, lead, and zinc) concentrates; the bullion was shipped to the Denver Mint. The mill treated an average of 26.6 tons daily. The flow sheet is as follows: Crushing in a 7 by 10 inch Blake crusher, grinding in two Marcy mills followed by plate amalgamation on three 4 by 16 foot copper plates, and concentration on three No. 5 Wilfley tables. The Camp Bird (Ltd.), in its annual directors' report and statement of accounts to June 30, 1928, says:

The company has maintained the mine and property in good order during the year. The lessees who have held a lease on the mine extending from the surface to the third level since October, 1925, have made considerable progress with their mining and milling program, but up to June 30, 1928, the [Camp Bird] company's receipts by way of royalty were inconsiderable.

Production on company account at the Camp Bird ceased June 30, 1916. The value of recovered metallic contents from May, 1902, the date of acquisition by the Camp Bird (Ltd.), to June 30, 1916, was \$23,234,256, with profit at the mine and mill of \$15,331,788. The total recovered value from this mine from 1896 to June 30, 1916, was \$27,269,768 and the profit, \$17,731,788. In December, 1916, the company began driving a lower adit beginning at the level of the mill and town site of Camp Bird, on Canyon Creek, 450 feet below the lowest workings. In 1918 the adit reached the vein 11,000 feet from the portal. In 1919 and 1920 the company drove drifts east and west from the adit and raised from the east drift to connect with the old workings, draining them of water. There has been no company development since 1920 and no ore extracted by the company since 1916, but lessees took an option on the upper levels in October, 1925, which resulted in creditable production in 1926, 1927, and 1928. From the Trust Ruby mine, near Sneffels, specimen gold was shipped in 1928 to the Denver Mint and a 1-ton lot of dry gold ore was shipped to the Golden Cycle mill.

Uncompahgre district (Ouray).—The Mutual Gold Mining Co. continued development work throughout the year at the American Nettie-Jonathan-Wanakah group and ran its 60-ton flotation mill at half capacity for several months, chiefly on ore from the American Nettie. The product was dry gold-silver concentrates. In addition, seven bars of amalgam gold-silver bullion from a strike of

specimen gold on the Jonathan were shipped to the Denver Mint, and a 2-ton lot of high-grade gold-silver ore was shipped to the Omaha smelter. The Wanakah mill, as remodeled in 1927 by the Mutual Gold Mining Co., is equipped as follows: 1 Blake 12 by 20 inch crusher, 6 amalgamation 4 by 5 foot plates, 1 Marcy 3 by 8 foot rod mill, 1 Akins 3 by 10 foot classifier, 1 Colorado Iron Works 5 by 5 foot ball mill, and 1 Ruth 8-cell flotation machine. Other production from the district was a 4-ton shipment of lead-silver-gold ore from the Galena prospect to the Leadville smelter and less than a half-ton lot of dry gold ore from the Speedwell to the Golden Cycle mill. The Sultan mill, at the mouth of Bear Creek, south of Ouray, was idle in 1928.

PARK COUNTY

Buckskin district (Alma).—A small lot of gold amalgam bullion from experimental tests on gold ore from the Paris-Excelsior group was sold to the Denver Mint. A 10-ton lot of dry gold-silver ore was shipped from the Loveland Mountain prospect to the Leadville smelter. At the "Sweet Home" group 775 feet of development work was done in 1928 and two narrow-gage cars of copper-lead-[zinc]-silver-gold ore were shipped to the Leadville smelter.

Consolidated Montgomery district (Alma).—A small lot of lead-silver ore was shipped from the Weber group to the Leadville smelter.

Hall Valley district (Webster).—A small lot of lead-silver-gold ore from the Ypsilanti group, a car of copper-lead-[zinc]-silver-gold ore from the La Clède-Missouri group, and a small lot of lead-silver ore from the Whale group were shipped to the Leadville smelter. In 1927 and in previous years ore from the La Clède-Missouri has contained bismuth, which at times has been made a part of the credit computation on the settlement.

Lake George district.—No ore was shipped from the Lake George district in 1928.

Mosquito district (Alma).—During 1928 the London Gold Mines Co., operator of the London Extension group (owned jointly by the London Extension Mining Co. and the London Mining & Milling Co.) and of the London group (owned exclusively by the London Mining & Milling Co.), expended in development work through what is known as the South London adit \$36,151.78 on the London Extension group and \$28,037.63 on the London group and shipped dry gold ore, containing a little silver and lead, from the London Extension to the Leadville smelter and to the Golden Cycle mill. The London Extension group includes the Flora A., Fraction, and Reconstruction claims. The Bagdad Smelting & Refining Co., lessee, shipped a car of dry-gold concentrates from its "North London" flotation mill at the mouth of the North London adit from ore from levels above the North London adit.

Tarryall district (Como).—The Ute Gold Mining Co. in May, 1928, reopened the Look property, 7 miles up Tarryall Creek from Como, and after cleaning out the adit drove it ahead several hundred feet. A small vein of pyrite and chalcopyrite was encountered which, when cobbled from the broken rock, resulted in a small shipment of gold-silver ore to the Leadville smelter.

PITKIN COUNTY

The total gross calculated value of the gold, silver, lead, and zinc estimated as recovered from ores mined in Pitkin County in 1928 was \$160,778, compared with \$250,804 in 1927. All the ore was shipped to smelters and was classified as follows: Dry-silver ore, 12,950 tons; lead-silver ore, 1,042 tons; zinc-lead-silver ore, 347 tons.

Avalanche Creek district (Carbondale).—A lessee on the Janeway prospect, 15 miles south of Carbondale, spent \$2,000 on development work during 1928. The property is opened by a 50-foot vertical shaft, 150 feet of drifts, and a 400-foot adit. Small shipments of lead-silver-copper ore have been made from this district in the past. At the Ground Hog-Double Decker-Gypsum group 100 feet of adit and 60 feet of raises were driven in 1928.

Lincoln Gulch district (Aspen).—At the Lincoln Gulch Metal Mines Co.'s property in Lincoln Gulch, 20 miles southeast of Aspen, 250 feet of development work was reported for 1928.

Roaring Fork district (Aspen).—All the production from Pitkin County came from mines at or near Aspen. With the exception of several hundred tons of zinc-lead-silver sulphide ore shipped from the Durant group to the zinc retort plant at Amarillo, Tex., and to the custom selective flotation mill at Bauer, Utah, several hundred tons of limey lead-silver sulphide ore from the Durgen property, and several hundred tons of limey lead-silver sulphide ore from the Park Tunnel group, all of the ore shipped was oxidized limey ore, chiefly valuable for its fluxing qualities at the A. V. smelter, Leadville, Colo. More than 10,000 tons of this lime rock, containing about 6 ounces of silver and 5.9 per cent of lead (wet assay) to the ton, was shipped from the Durant-Late Acquisition-Smuggler group. Ore of the same type but with slightly varying assays for silver and lead was shipped from the Aspen Fraction, the Newman Tunnel group, and Spar group; this ore came chiefly from old stopes, without much development work. The lessee on the Durgen property drove 350 feet of drifts and raises. About 400 feet of new development was done at the Durant-Late Acquisition-Smuggler group. From the 3,100-foot adit of the Park Tunnel group 100 feet of drifts were run in 1928. From the Winnie claim of the Midnight Mining Co. an upper adit 300 feet long opened a lead-silver oxidized ore body, from which one car was shipped in 1928. No production was made in 1928 from the Midnight main drainage and transportation 6,700-foot adit, but 100 feet of adit, 237 feet of raise, and 210 feet of crosscut from the top of raise were driven. Openings on the Midnight group also include 1,000 feet of drifts and a 500-foot shaft. No work was done at the Hope adit, which starts on Castle Creek and runs 6,500 feet (11,000 feet of workings in all) northeasterly toward the Little Annie shaft.

The Smuggler 400-ton jigs-tables-vanners concentration mill (last operated in 1926) remained idle. It was originally built in 1888, and the equipment as of February, 1929, is as follows: 1 Blake crusher, 4 trommels, 3 Huntington pulverizers, 2 screens, 2 Roger rolls, 2 Hardinge tube mills, 10 Frue vanners, 20 Hallett concentration tables, and 6 German-made jigs.

RIO GRANDE COUNTY

Summitville district.—Lessees on the Little Annie mine at Summitville, 28 miles southwest of Del Norte, in 1928 continued to ship high-grade gold quartz ore and specimen gold to the Golden Cycle mill and specimen gold to the Omaha (Nebr.) smelter. In 1928 additions to the equipment included a powder magazine, an ore house, a blacksmith shed, a surface tram shed, waterworks, and general repairs to the boarding house. Development at the mine in 1928 consisted of 12 feet of winzes, 390 feet of drifts, and 160 feet of raises. This property was an important producer in the seventies and has been an occasional producer since; it was reopened in 1926 by a lessee who had known for 20 years of an extraordinary outcrop of gold which lay in an unworked part of the property. In 1926 twenty-one tons of quartz containing free gold yielded 5,118.02 fine ounces of gold. In 1927 one hundred and thirty-seven tons of ore returned \$117,826.49 in cash, after hauling, freight, and treatment costs were deducted. In 1928 returns after freight and treatment were deducted were \$212,942.62. In 1928 assessment work was done on the Esmond, Chandler, and Garfield claims. In the summer of 1928 a flotation mill was being installed at the Miser-Guadalupe group at Jasper, on South Mountain.

ROUTT COUNTY

Hahns Peak district.—In 1928 the Primary Industries Corporation took over the Master Key group, built a shaft house, installed machinery, and began sinking a vertical shaft on the geological inference that replacement ore bodies may be found in limestone beds between 237 and 322 feet below the surface.

SAGUACHE COUNTY

The total gross calculated value of metals estimated as recovered from ore mined in Saguache County in 1928 was \$1,438,048, compared with \$1,321,640 in 1927.

Blake district (Mirage).—In 1928 a small mill, equipped with a 5-ton Chilean mill and a Wilfley table, was built at the Bob Lee claim, and 30 feet of development work was added to the 210 feet of adits and 50 feet of earlier development.

Crestone district.—Jefferson Bros., of Crestone, continued the adit on the Sunset claim from 145 feet to 175 feet and extracted 3 tons of ore, which was shipped in a lot of 2½ tons to the Golden Cycle mill and a lot of one-half ton to the A. V. smelter at Leadville. These trial shipments averaged 2 ounces of gold to the ton. A 5-stamp amalgamation mill was built at the Independence-North Star group, once a small producer. This group has openings totaling 700 feet.

Kerber Creek district (Bonanza).—The Rawley Mines (Inc.) 350-ton flotation mill on Squirrel Gulch, a tributary of Kerber Creek, near Bonanza, was operated steadily at a daily average of 321 tons in 1928, except for an idleness of three weeks while the company was completing a tailings dam. The mine was operated 365 days. Development work in 1928 totaled 4,704 feet. The mill is at the portal of the Rawley 6,600-foot adit, and the lead-copper-iron-silver-gold-

[zinc] sulphide concentrates are carried by a 7¼-mile aerial tramway northward over the divide to Shirley station, on the Denver & Rio Grande Western Railroad's Salida-Montrose narrow-gage branch, for shipment to Salida; at Salida the concentrates are transferred to broad-gage cars for movement to the A. V. smelter at Leadville. The mill was remodeled in 1926 and has been operated under the present management six months in 1926 and all of 1927 and 1928. Prior operation ceased December 1, 1923. The equipment of the mill is as follows: 1 Allis Chalmers No. 5 K gyratory crusher, 1 Allis Chalmers 54 by 24 inch set of rolls, 2 Hardinge 8 by 2½ foot conical ball mills, 2 Dorr 6-foot classifiers, 2 Minerals Separation Sub A 12-cell flotation machines, 4 Allen (total 39 cells) flotation machines, 1 Oliver 6-foot and 1 Oliver 8-foot filter, and 2 Dorr thickening machines, one of which is 50 by 12 feet. The Antoro, Paragon, and Michigan groups were leased on December 20, 1928, to the Rawley Mines (Inc.), which is a subsidiary of the American Smelting & Refining Co.

Little development was done on other properties in the Kerber Creek district. None was done on the Bonanza-Cocomongo group, and little was done on the Henry, Now What, Saratoga, and Vienna groups. At the Pershing claim, of the Express-Headlight group, the surface outcrop of the fissure vein carries chiefly manganese oxide and quartz, from which 75 tons of ore carrying about 40 per cent of manganese was cobbled. Similar veins in this district usually change at short depth to rhodochrosite, quartz, and silver minerals.

Orient district (Villa Grove, Mineral Hot Springs).—On the eastern side of the San Luis Valley, east of Villa Grove and Mineral Hot Springs, is the Colorado Fuel & Iron Co.'s Orient iron mine, from which iron oxide ore goes to the company's iron and steel mill at Pueblo.

SAN JUAN COUNTY

Animas district (Silverton).—Less and less does custom continue to use the names and the rather indefinite boundary lines of mining districts that were set up prior to the organization of the State and county governments but that have no legal status to-day. The Animas district of San Juan County includes the area in the immediate vicinity of Silverton and east of the Animas River from Silverton to Middleton. In this area, producing mines in 1928 were the Aspen, Iowa Tiger, Lark, Little Fannie, Mayflower, Pride of the West, Queen City, and Valley Forge.

In 1928 the Shenandoah-Dives Syndicate, which owns the Shenandoah, Dives, Dives Fraction, Terrible, and Mayflower groups, moved its base of operations from the Dives-Shenandoah, 5 miles from the Silverton Northern Railroad, to the Mayflower, 1.3 miles from the railroad. The syndicate did 1,960 feet of development work. It rented the 40-year old building of the Iowa Gold Mining Co. and set within it a new milling plant of modern machinery for use as a pilot mill. The remodeling was done in the first half of 1928; thereafter the ore taken out in development of the Mayflower was milled at a daily average of 95 tons. The equipment of the remodeled mill is as follows: 1 Denver Engineering Works 11 by 18 inch crusher, 1 Stearns Rogers trommel, 1 Stearns Rogers 6 by

5 foot ball mill, 1 Dorr Simplex $3\frac{1}{2}$ by 18 foot classifier, 3 Wilfley tables, 1 Minerals Separation 14-cell flotation machine, 1 Dorr 60 by 24 inch filter, and 1 Dorr 10 by 18 foot thickening tank. The mill is in Arastra Gulch, 3,700 feet from the mine portal, and the two are connected by an aerial tram.

The ore is chalcopyrite and pyrite, accompanied by some sphalerite, in a quartz gangue. Concentrates produced were lead-copper-[zinc]-gold-silver sulphides. The Colorado-Mexico Mining Co., lessee on the Iowa-Gold Tiger group, availed itself of the opportunity to send some of its ore to the Shenandoah-Dives pilot mill but spent most of its energies on development work—sinking a 5 by 13 foot incline shaft 100 feet and driving 95 feet of drifts and 60 feet of crosscuts. The openings on the Iowa-Gold Tiger are: Vertical shaft, 175 feet; incline shaft, 410 feet; drifts, 4,500 feet. The ore carries galena, chalcopyrite, and sphalerite. Several cars of lead-copper-silver-gold sulphide ore from the Aspen and one to three cars each of lead-silver-gold sulphide ore from the Lark, Little Fannie, and Pride of the West were shipped to the Durango smelter. The lessee on the Valley Forge shipped one car of complex gold-silver-lead-zinc sulphide ore to the Sunnyside selective flotation mill at Eureka.

The Highland Mary mill and power plant were repaired in 1928. One hundred and ten feet of drifting was done at the Joe & John. Repairing of the Copper Bell adit was in progress. The Vertex Mining Co., a subsidiary of the Tonopah Mining Co., sank the main shaft (which is a winze sunk from the adit level, the adit level here being about 650 feet from the surface) 200 feet from the 200-foot level to the 400-foot level. On the 300-foot level of this shaft 100 feet of drifts and crosscuts were run. On the adit level two crosscuts were run 94 feet into the foot and hanging wall of the vein. All of this work was done on what is known as the Smuggler-Union claim. The ore developed is a dry gold-silver ore. The Lackawanna Mining Co. built a 50-ton gravity concentration and flotation mill at the Lackawanna property in the summer of 1928 but did not operate it in 1928.

Eureka district (Eureka, Silverton).—The Eureka district appears to include all the area from Red Mountain to Animas Forks, west of the Animas River. In 1928 the Lucky Jack prospect, 11 miles southeast of Ouray, but in San Juan County, was opened. Development on this group in 1928 consisted of 60 feet of drift, 27 feet of vertical shaft, and 10 feet of crosscut. A 4-ton lot of dry gold and silver ore was shipped in 1928. The Sunnyside mine of the United States Smelting, Refining & Mining Co., on Hanson Mountain, was operated steadily in 1928. This mine is at an altitude of 13,200 feet; it is connected by a 16,000-foot aerial tram with the 1,000-ton selective flotation mill at Eureka on the Silverton Northern Railroad. Development work at the mine in 1928 totaled 4,596 feet. This company was one of the first (in 1912) to use selective flotation in the treatment of a complex low-grade zinc-lead-copper-iron-silver-gold sulphide ore. The present mill was built in 1917, and the practice as of 1926 was described by Robie.⁸ The capacity of the present mill has been enlarged from time to time from 500 tons a day to 1,000 tons rated capacity in 24

⁸ Robie, E. H., Selective Lead-Zinc Flotation at Sunnyside: Eng. and Min. Jour., vol. 121, 1926, pp. 542, 757-762.

hours. In 1928 the daily average treated was 900 tons. As of March, 1929, the equipment was as follows: 2 Gates No. 6-K gyratory crushers (at the mine), 2 Farrel 13 by 30 inch jaw crushers, 3 Denver Engineering Works 5 by 14 and one 5 by 8 foot tube mills, 3 Marcy No. 86 ball mills, 7 Dorr duplex classifiers, 11 No. 6 Wilfley tables (for control), 1 Minerals Separation 10-cell 24-inch Sub A flotation machine, 1 Minerals Separation 10-cell 24-inch Standard flotation machine, 1 Minerals Separation 22-cell 24-inch Standard flotation machine, 1 Minerals Separation 16-cell 24-inch Standard flotation machine, 3 Oliver filters, 1 Portland 12 by 9 foot and 1 Portland 12 by 3½ foot filter, and 3 Dorr thickening tanks (one 8 by 25 foot, one 10 by 28 foot, and one 8 by 15 foot). Products from the mill in 1928 were high-grade zinc concentrates, carrying also lead, copper, silver, and gold, which were shipped to Oklahoma-Texas zinc-retort plants (residues from the zinc retorts going to El Paso, Tex.); high-grade lead concentrates, carrying much more than half the total recovered gold and silver, which were shipped to the Durango smelter; and a small tonnage of zinc-lead middling, carrying less gold and silver in all than the zinc concentrates but carrying five times as much gold and two and one-half times as much silver per ton as the zinc concentrates. The middling was shipped to the Read-Coolbaugh sulphating plant at the Durango smelter, where the soluble zinc sulphate produced by the roasting was leached out and the residue sent to the lead furnaces. Much of the zinc sulphate is sold as a chemical reagent for use in flotation plants.

Assessment work, repairs to buildings, roads, and bridges, mine timbering, building truck garage, and testing, altering, and experimenting with the mill were done in 1928 at the Caledonian Mining & Milling Co.'s property in T. 42 N., R. 6 W. of New Mexico principal meridian. Near the close of 1928 or early in 1929 the Frisco Tunnel property, including the Red Cloud and other claims, was leased to the United States Smelting, Refining & Mining Co., under an agreement that that company would operate the property in conjunction with the operations of the Sunnyside Mining & Milling Co. On December 31, 1928, the Golconda San Juan Mines (Inc.) purchased the former Lake Mountain Mining & Reduction Co.'s holdings, including the San Juan Chief mine; in 1928 approximately \$10,000 was spent on the mines. Development on the San Juan Chief is as follows: 300 feet of main shaft and four shafts totaling 51 feet.

SAN MIGUEL COUNTY

The mines of San Miguel County in 1928 produced 188,406 tons of ore, yielding \$528,093 in gold, 665,282 ounces of silver, 110,896 pounds of copper, and 6,530,431 pounds of lead, with a total gross calculated value of \$1,312,017, compared with 312,490 tons of ore and \$2,118,333 in 1927. The Smuggler-Union mine closed on December 11, 1928; the shutdown will cause a heavy decrease for this county in 1929.

Iron Springs district (Ophir).—The Ophir district in 1928 produced 20,201 tons of ore, yielding \$6,710 in gold, 155,253 ounces of silver, 80,618 pounds of copper, and 3,356,758 pounds of lead, with a total gross calculated value of \$303,834, compared with \$362,579 in 1927. The principal producing mine was the Carbonero. It is opened by a crosscut adit 2,200 feet long. There are 4,000 feet of drifts on 5

levels, connected by a 600-foot raise. Development in 1928 consisted of 800 feet of drifts and 150 feet of raises. The ore of this mine as milled carried about 10 per cent of lead and 7 ounces of silver to the ton and was the highest grade strictly lead ore milled in the State. In addition, smelting ore carrying 48 per cent of lead and 34 ounces of silver to the ton was shipped to the Durango smelter. The mill was operated continuously at a rate of 50 tons a day; the product was high-grade lead-silver concentrates. The equipment of the mill consists of 1 Universal No. 3 crusher, 1 Ruth 3 by 9 foot rod mill, 1 Deister rougher table, 2 Deister pilot tables, 1 Deister sand table, 1 Ruth 8-cell flotation machine, and 4 settling tanks. Development work was continuous at the Butterfly-Terrible group; the new mill (built in 1927) was operated 40 days. This property is opened by 9,000 feet of adits, 600 feet of drifts, and an 850-foot vertical shaft. In 1928 development work consisted of 550 feet of shaft and 600 feet of drifts. The mill adjoins the portal of the adit and its equipment is as follows: 1 Allis Chalmers gyratory crusher, 1 impact screen, 1 Colorado Iron Works 5 by 6 foot ball mill, 1 Akins classifier, 2 Fahrenwald 6-cell flotation machines, 1 American 3-leaf filter, 2 agitation tanks, and 1 Dorr 18-foot thickening tank. The ore is a dry silver sulphide, and the concentrates made are lead-silver with a little gold, copper, and zinc. About 70 tons of ore from the Iron Mountain property was milled, making 7 tons of lead-copper-silver-gold concentrates. About 400 feet of drifting was done on the Ida vein, and 81 tons of lead-copper-[zinc]-silver-gold ore was shipped to Durango. The San Bernardo mine and mill, which made an important production in 1927, were idle after January 10, 1928. The equipment of the mill consists of 1 Gates gyratory crusher, 2 Allis Chalmers 6 by 5 foot ball mills, 1 Dorr duplex classifier, 1 Minerals Separation 12-cell flotation machine, 1 American continuous filter, and 1 agitation tank. The product was lead-copper-silver-gold concentrates.

Lower San Miguel district (Sawpit).—No development was done or production made from gold-silver-lead-zinc prospects in the Lower San Miguel district in 1928. The vanadium properties, closed in 1920, remained idle.

Upper San Miguel district (Telluride).—Two mines and ten prospects in the Upper San Miguel district in 1928 produced 168,205 tons of ore, yielding \$521,383 in gold, 510,029 ounces of silver, 30,278 pounds of copper, and 3,173,673 pounds of lead, with a total gross calculated value of \$1,008,183, compared with 267,971 tons of ore and \$1,755,184 in 1927. The Smuggler-Union mine was the only important producer. The other producer was the Alta mine. Very little was done at the Alta mine other than keeping the workings open, but the 300-ton mill was operated for a few weeks, producing lead-copper-silver-gold concentrates. The equipment of this mill consists of 1 Allis Chalmers crusher, 2 Marcy ball mills, 2 Dorr classifiers, 6 No. 6 Wilfley tables, 7 J. B. flotation machines, 3 homemade flotation machines, 1 Minerals Separation flotation machine, 1 Colorado Iron Works filter, and 2 Dorr thickening tanks.

A fire on October 20, 1927, which destroyed the surface workings of the Pennsylvania adit of the Smuggler-Union group, curtailed production until the internal shaft could be converted from a man-

hoisting to an ore-hoisting unit to make the ninth level the main outlet. The mine and mill closed down December 11, 1928, and liquidation of the Smuggler-Union Mining Co. followed. The Smuggler-Union Mining Co. had two mills, one an old 60-stamp mill of about 650 tons capacity in 24 hours and one an 850-ton flotation mill, built in 1920. Crushing was done at the mine by three gyratory 250-ton crushers. The ore was carried by aerial tram to mills at Pandora; the equipment of these mills consisted of 60 stamps (1,050 pounds), 1 Allis Chalmers ball mill, 3 Hardinge 6-foot by 22-inch ball mills, one 6 by 4½ foot Marcy mill, 3 Akins classifiers, 2 Dorr classifiers, 21 Standard Wilfley tables, 32 Allen flotation machines, 2 Portland 8 by 6 foot filters, and 3 Dorr 20 by 16 foot thickening tanks. The history, production, geology, mining methods, and metallurgical methods and results at this mine, which in all has had a life of 52 years, are given in an article by the company's president and general manager.⁹ Abstracts of this history were quoted in the 1927 report of this series.

The local purchaser of the equipment and property of the Tomboy Gold Mines Co. (Ltd.) (closed and liquidated early in 1927) made several sales of clean-up gold-silver bullion to the Denver Mint and to other United States assay offices and of other gold-silver-bearing material to the Durango and Omaha smelters.

SUMMIT COUNTY

The total gross calculated value of metals recovered from Summit County lode and placer mines in 1928 was \$391,008, compared with \$532,952 in 1927.

Breckenridge district.—The total gross value of the combined output of lode and placer mines in the Breckenridge district in 1928 was \$380,970. From June 1 to August 31 a ¼-yard gasoline-propelled steam shovel dug 6,000 cubic yards of stream and bench gravels at the Bemrose-Bostwick placer in Hoosier Gulch, near Hoosier Pass. The gravel was dumped over grizzlies and into sluice boxes, where gold-silver bullion averaging 0.783¾ gold and 0.192½ silver was recovered. Placer ground in this property totals 266 84 acres. The length of ditches owned totals 4 miles. The Blue River Placer Mining Co., operating an electrically driven dredge of 88 buckets, each with a capacity of 8½ cubic feet, deposited gold-silver bullion at the Denver Mint monthly (except March) from January 12 to August 10, 1928. This bullion after melting averaged 0.783 gold and 0.198 silver. Sluicing operations on the Arctic-Galena Gulch-Peabody placers recovered some gold-silver bullion, which after melting at the Denver Mint averaged 0.778¾ gold and 0.185½ silver. Small sluicing operations on the Kelley and Louis D placers recovered a little gold-silver bullion. Fineness of the Kelley placer bullion after melting was 0.767¼ gold and 0.221½ silver and of the Louis D, 0.737½ gold and 0.257½ silver. Six weeks of hydraulicking at the Berlin placer recovered a small quantity of gold-silver bullion, which after melting at the Denver Mint averaged 0.631½ gold and 0.300½ silver.

⁹ Livermore, Robert, *Prolonging the Life of the Smuggler Union Enterprise*; Eng. and Min. Jour., vol. 125, Mar. 31, 1928, pp. 525-532.

Dry gold and silver mixed sulphide and oxide ore from the Detroit-Hicks mine was treated in the Extension 60-ton concentration and cyanidation mill. This mill is equipped with 1 crusher, 1 ball mill, 1 classifier, 3 concentrating tables, 1 flotation machine, 1 agitation tank, 3 leaching tanks, and 1 thickening tank. The cyanidation department was not used actively in 1928. The product was chiefly concentrates, which were lead-[zinc]-silver-gold. One car of lead-silver ore each from the Dunkin, from the Gold Dust, and from the Royal Tiger and a 3-ton lot of dry silver ore and a 6-ton lot of lead-silver-gold ore from the Silver King were shipped to the A. V. smelter at Leadville. The Royal Tiger pilot mill was operated intermittently, yielding lead-silver-gold concentrates. Development on the Gold Dust in 1928 consisted of about 400 feet of drifts, raises, and crosscuts and 50 feet of shaft.

The Wellington Mines Leasing Co., which took over the operation of the Wellington mine April 1, 1927, and completed and operated a 125-ton selective flotation mill from August 23 to November 28, 1927, resumed operations at both mine and mill in July, 1928, and continued throughout the rest of the year. Development work at the mine totaled 905 feet of raises, 1,150 feet of drifts, and 628 feet of crosscuts. No changes were made in the equipment of the new mill, which consists of 1 Blake 9 by 15 inch crusher, 1 set Mine & Smelter Supply Co.'s 16 by 36 inch rolls, 1 Stearns Rogers 6 by 5 foot ball mill, 1 Dorr Model D classifier, 4 Standard Wilfley tables, 2 Minerals Separation 12-cell 18-inch Sub A flotation machines, 1 American 6-foot 5-leaf filter, 1 homemade 14-foot 25-inch diameter revolving drum dryer, 1 Dorr thickening tank, and 1 V thickening tank. Zinc concentrates carrying a little lead, silver, and gold went to Henryetta, Okla., and Amarillo, Tex.; lead-silver-gold-[zinc] concentrates went to the A. V. smelter at Leadville. At the Juniata group 300 feet of drifts and 50 feet of raises were driven.

Montezuma district.—At Montezuma the Pennsylvania gravity concentration-flotation mill was operated part of the year on ore from that part of the Pennsylvania vein outcropping on the Paymaster claim. The equipment of this mill consists of 1 Blake 9 by 15 inch crusher, one 8-mesh 3 by 6 foot trommel, 2 McFarlane 16 by 36 inch rolls, 1 Colorado Iron Works 5 by 5 foot ball mill, 1 Dorr duplex 16-foot classifier, 3 overflow feed classifiers, 8 Standard Card tables, 1 Harz 12-inch jig, 1 Minerals Separation 8-cell flotation machine, 1 Oliver 6 by 4 foot filter, 2 cone agitation tanks, and 2 Dorr 16 by 10 foot thickening tanks. Two cars of lead-silver-gold ore each from the Bell-California and from the Ida Belle and one car of similar ore from the St. John Extension (or Sutton) were shipped to the A. V. smelter at Leadville. New drifts at the Eureka group totaled 100 feet. Development work at the Silver Tip totaled 300 feet. Development work was also done at the Burke group, Hall-Silver Spoon group, More Work-Vanderbilt, Morgan, Mozart, Rainbow, Silver Dove, Spelter King, and Tempest.

Ten Mile district (Frisco, Kokomo, Robinson).—A car of lead-silver-gold ore from the "Four-Most" group, in the Wilkinson sub-district, near Frisco, was shipped to the A. V. smelter at Leadville. In the same subdistrict assessment work was done at the Frisco lode claim and 400 feet of crosscut was driven at the Square Deal. At

the King Solomon group, opened by a 5,250-foot adit, below Curtin, several short raises were put up on a fissure 3,600 feet from the portal. At Kokomo and Robinson no development work was done except assessment work on a few unpatented claims; no ore was mined from this area, once an active district and still containing some blocked out pyrrhotite-pyrite and sphalerite-galena deposits.

TELLER COUNTY

Mine and dump siliceous sulpho-telluride gold ores, telluride and pyrite concentrates, mill slags, clean-ups, and stolen specimen gold from the Cripple Creek district aggregated in recovered gold to United States mints and to smelters, 147,987.88 fine ounces, valued at \$3,059,181, compared with \$3,307,505 in 1927, and 18,841 ounces of silver, compared with 25,344 ounces in 1927.

As in the past several years Cripple Creek ores went to the Portland-Independence nonroasting gravity concentration-selective flotation-cyanidation mill at Victor and the Golden Cycle roast-amalgamation-cyanidation mill at Colorado Springs. Concentrates from the Portland mill went to the Golden Cycle mill after April, bullion from both mills went to the Denver Mint, and slags and clean-ups went to the A. V. smelter at Leadville. The Omaha (Nebr.) refinery was also a market for bullion, specimen gold, and high-grade gold ore.

The Golden Cycle mill continued to accept Cripple Creek ores containing under 0.20 ounce gold, or \$4 per ton calculated at its payment of \$20 an ounce, at \$1.75 treatment charges; in December freight charges were reduced from \$0.75 to \$0.50 on ore up to \$4, inclusive. The rates as of December, 1928, were:

Cripple Creek treatment rates, Golden Cycle mill, December, 1928

Ore up to \$4 per ton, inclusive.....	\$1.75 plus \$0.50 freight.
Ore up to \$5 per ton, inclusive.....	\$1.75 plus \$0.75 freight.
Ore up to \$8 per ton, inclusive.....	\$2.25 plus \$1 freight.
Ore up to \$10 per ton, inclusive.....	\$4 includes freight.
Ore up to \$15 per ton, inclusive.....	\$5.25 includes freight.
Ore up to \$20 per ton, inclusive.....	\$6.25 includes freight.
Ore up to \$25 per ton, inclusive.....	\$6.60 includes freight.
Ore up to \$30 per ton, inclusive.....	\$6.90 includes freight.
Ore up to \$40 per ton, inclusive.....	\$7.50 includes freight.
Ore up to \$100 per ton, inclusive.....	\$8.60 includes freight.
Ore over \$100 per ton.....	\$5.50 plus \$3.10 freight unless released.

Payment: \$20 an ounce for gold.

The flow sheet of the main Golden Cycle mill for treatment of Cripple Creek ores has not been materially changed since its last description by Blomfield and Trott.¹⁰ The ore goes to a sampling mill and then to storage bins for different classes of ore. The classes formerly were determined by calcium oxide content.¹¹ The ore from the storage bins is divided between 1 Hardinge ball mill and 5

¹⁰ Blomfield, A. L., and Trott, M. J., Roasting for Amalgamating and Cyaniding Cripple Creek Sulpho-Telluride Gold Ores; Trans. Am. Inst. Min. Eng., vol. 60, 1919, pp. 118-132; The Golden Cycle Cyanide Plant; Chem. and Met. Eng., vol. 19, No. 12, 1918, p. 796.

¹¹ This system was discarded in 1928 or previous to 1928. See Dycus, M. F., Ore Treatment Methods and Practice in the Golden Cycle Mill; Min. Cong. Jour., vol. 15, No. 12 December, 1929, pp. 965-968.

Schmidt Kominuters operating in closed circuit with Hummer screens. The screen undersize goes to 9 coal-fired 115 by 15 foot Edwards Duplex roasters. The roaster product goes to 7 Evans-Waddel 6-foot Chilean mills grinding in the alkaline-cyanidation mill solution. Each Chilean mill is followed by 2 blanket concentrating tables, and the tailings from the blanket tables go to 15-foot Dorr Bowl classifiers. The sand product of the classifiers goes to eleven 50 by 6 foot leaching tanks using a countercurrent decantation leaching system. Sand tailings are flushed to the tailings dump. The slime product from the classifiers goes to the slime leaching plant using thickeners and agitators. The development and application of the Golden Cycle "Superthickener" (now called Hardinge Superthickener or Clarifier) in the slime leaching plant has been described by Noel Cunningham.¹² Tailings from the slime plant are filtered on 2 stationary 86-leaf Moore filters. Gold solution from both leaching plants is clarified, deoxidized in a Crowe vacuum system, and precipitated in Cascade-type zinc boxes. Merrill zinc presses are used in the clean-up.

In 1927, at the Golden Cycle plant, a separate 40-ton nonroasting all-sliming unit consisting of a sampler, a Marcy ball mill, Dorr classifier, and Dorr thickener and agitating tanks was installed to treat siliceous and sulphide ores from Colorado districts other than the Cripple Creek district. In 1928 ores received from other districts in Colorado were gold tellurides and gold siliceous and sulphide ore from Boulder County; sulphide gold ores and concentrates from Clear Creek, Gilpin, and Lake Counties; specimen gold ore from Rio Grande County; and silver oxidized ore from Creede, Mineral County. Treatment rates on these ores as of October 30, 1928, were as follows:

Treatment rates for miscellaneous gold and silver ores at the Golden Cycle mill, Colorado Springs, Colo., October 30, 1928

Ore up to and including \$10 per ton-----	\$3. 00
Over \$10 and including \$15 per ton-----	3. 50
Over \$15 and including \$20 per ton-----	4. 00
Over \$20 and including \$40 per ton-----	5. 00
Over \$40 per ton-----	5. 50

The above rates are exclusive of freight charges.

\$20 per ounce paid for gold when settlement value is 0.03 ounce per ton or more.

Pay for silver as quoted on market, day of settlement, excluding fraction of cents:

	Per cent silver value
Containing 1 ounce and including 5 ounces-----	50
Over 5 ounces and including 10 ounces-----	65
Over 10 ounces and including 20 ounces-----	75
Over 20 ounces and including 50 ounces-----	85
Over 50 ounces and including 100 ounces-----	90
Over 100 ounces-----	95

When containing both gold and silver, ores containing 20 ounces silver or over, \$1 per ton will be added to treatment rates.

In 1928 the combined average daily tonnage treated at the two mills of the Golden Cycle was 852 tons.

¹² Cunningham, Noel, *The Golden Cycle Superthickener and Clarifier*: Eng. and Min. Jour., vol. 119, No. 22, May 30, 1925, pp. 905-907.

The Portland-Independence company and custom mill at Victor was operated up to December 1, 1928. A brief review of the metallurgical treatment of Cripple Creek ores from 1892 to 1927, with special reference to the five different reduction plants (during that period) of the Portland Gold Mining Co. and a detailed description of the 1927 operation of the Portland-Independence mill, has been written by J. M. Tippet.¹³ The flow sheet (and equipment) of the Portland Independence mill shows that the coarse ore is drawn from the receiving bins to two 7½-D Gates crushers, then into two 20 by 72 inch roll sets, and through a sampling unit to six fine-ore bins of 2,500 tons capacity. The fine ore is fed to six Chilean mills followed by six Akins classifiers. The classifier sands are advanced to six 6 by 6 foot ball mills operating in closed circuit with six additional Akins classifiers. Alkaline-cyanide mill solution (0.25 pound cyanide and 1 pound CaO per ton) is used in the fine-grinding machines. The overflow from the 12 classifiers is advanced to the four 8-cell Ruth flotation machines, where 0.3 pound of a reagent mixture of 90 per cent of fuel oil and 10 per cent of pine oil is added per ton. High-grade flotation concentrates, amounting to about 1 per cent of the total ore treated, are made. Flotation tailings are tabled with 34 rougher and 11 finishing tables, making concentrates which join the flotation concentrates, a middling which is returned to the ball-mill circuit, and tailings which are advanced to the low-grade thickener tanks. The combined flotation and table concentrates are thickened (overflow solution used in tabling) and charged in batches to a 5 by 14 foot tube mill with 2-inch grinding balls. Two tons of alkaline-cyanide solution per ton of concentrates is added and the mill sealed and rotated for one and one-half hours. It is claimed that the reducing action of the evolved hydrogen effectively conditions the concentrates for subsequent dissolution in cyanide solution. The concentrates are discharged to three high-grade agitation tanks (in series), and the solution (and pulp), after agitation, is returned to the main mill circuit, joining the flotation tailings. It eventually joins the table tailings and is advanced to the low-grade thickening and agitation tanks.

The remainder of the mill equipment consists of 4 Merrill slime presses, 1 Crowe vacuum system, 2 zinc-dust feeders, 6 Merrill zinc presses and accessory pumps, sumps, and tanks.

In the annual printed report of the Portland Gold Mining Co. for the calendar year 1928 the superintendent of the Independence mill reports on its operation as follows:

A very marked decrease in the tonnage input at the mill, together with a corresponding decrease in the average value of the ore, caused a decrease in the profits earned for the year. The average value of the mill heads dropped from \$5.02 for the first 11 months of 1927, to \$3.59 for the first 11 months of 1928. The total tonnage for the same months of 1927 was 183,675.02 tons, while for the same months of 1928 it had dropped to 134,054.31 tons, or a decrease of approximately 4,500 tons per month. Notwithstanding this decrease in both value and tonnage of ore treated, there was an appreciable decrease in operating expense, per ton of ore treated, for the 11 months that the mill was in operation during 1928.

¹³ Tippet, J. M., Flotation of a Gold Ore in a Cyanide Solution: Eng. and Min. Jour., vol. 124, July 30, 1927, pp. 181-183.

The treatment of the table concentrates at the Independence mill was discontinued in April, 1928, and this product was shipped to the Golden Cycle mill at Colorado City for treatment. The bullion and concentrates sold during the first 11 months of the year amounted to \$447,432.01, which return shows an extraction of 90.3 per cent, based upon gross value of ore received at the mill and the returns from shipments of bullion and concentrates. This sum does not include the shipment of bullion from final clean-up of mill after closing down which was \$26,407.79.

MINES REVIEW

Mineral Hill.—Lessees on the Plutocrat prospect continued development work to June 1, 1928. In that period they shipped 160 tons of gold ore. The development on this property is reported by the lessees as follows: A 200-foot vertical shaft, 700 feet of drifts, and 90 feet of adit.

Carbonate Hill.—The Jay Gould Mining Co. shipped one car of ore from the Kittie Wells.

Poverty Gulch.—By September 30, 1928, a lessee on the El Paso-Gold King had driven 125 feet of drifts, 25 feet of winze, and 50 feet of raise and had shipped several hundred tons of ore. A car of dump ore was shipped from the C. O. D.

Tenderfoot Hill.—The Reclamation Metal Mines Co. shipped one small lot of ore from the Black Diamond group and Sangre de Christo adit before turning the property over on bond and lease to the Dictator Gold Mines (Inc.); the new company did some development work but made no shipments.

Galena Hill near Cameron.—Dump ore from the Sunshine group was shipped in 1928.

North slope of Ironclad Hill.—The Osten Leasing Co. shipped several thousand tons of ore from the Jerry Johnson. The Damon (Axtel) and W. P. H. groups of the United Gold Mines Co. shipped 1,702 tons and 4,259 tons, respectively. The Queen Metals Co. did 300 feet of drifting and 500 feet of raising and shipped 5,600 tons from the Forest Queen. The Forest Queen is opened by a 900-foot shaft and nine levels.

Gold Hill.—Dump ore was shipped from the Anchoria-Leland, Index, Matao, and Midget.

Raven and Guyot hills.—Producing mines were the Cresson, Doctor-Jack Pot dump, Jo Dandy, Mary McKinney, Moose dump, and Queen. The annual report of the Cresson Consolidated Gold Mining & Milling Co. for the 12 months ended August 31, 1928 (dated January 10, 1929), says:

During the fiscal year 106,041 dry tons of ore were shipped of a gross value of \$977,158.99, averaging \$9.21 per ton; the returns, less transportation and treatment, were \$568,418.92, giving the ore a net value of \$5.36 per ton. The company received as additional income the sum of \$12,574.85 interest on bank deposits and the sum of \$44.98 net royalties from 708 tons of ore shipped by lessees, making a grand total of \$581,038.75, with total expenses of \$534,245.81, resulting in a net gain from operations of \$46,792.94. The total cost per ton of ore produced was \$5.04. This is a decrease of 46 cents per ton over 1927.

You will note in our company's production of 106,041 dry tons, with an average return of \$5.48 per ton, our entire cost was \$5.04 per dry ton, resulting in a net profit of \$0.44 per ton.

Total cash at the close of the fiscal year ending August 31, 1928, was \$395,959.09.

Costs at the Cresson mine, fiscal year ended August 31, 1928

	Per ton
General expense-----	\$0. 003
Taxes-----	. 070
Insurance-----	. 114
Salary officers-----	. 090
Colorado Springs office-----	. 100
Mining operations (including mine management and engineering)-----	4. 613
Dante operations-----	. 050
	5. 040

In extending development work below the Roosevelt Drainage Tunnel (17th level) the ore value proved substantially lower than indicated when first encountered.

The high cost of prospecting, mining, and pumping from deep levels resulted in a very small profit to the company. It is expected to complete the mining operations below the tunnel level in about six months, thereby materially reducing cost of operation.

Following is a summary of development work for year ending August 31, 1928:

<i>Development</i>	Feet
Drifts and crosscuts-----	5, 159
Raises-----	1, 590
Prospecting—diamond drilling-----	1, 094
Dante drifts and crosscuts-----	800
	8, 643

During the year intensive development work has been done on lower levels of the mine, both with machines and diamond drilling.

Drill holes have been run below the bottom level at different angles to cut the ore-bearing formation. While these holes show low-grade ore, it is not of sufficient value to justify sinking the shaft and pumping the large flow of water which will be encountered.

On the upper levels development has shown some large low-grade ore bodies and a number of smaller ones of good average value.

The production is being made from the levels below the tunnel, so that the pumps may be removed when ore is extracted. This will reduce mining expenses.

The development work is being done on 19 and practically all the levels above 17, which is the Roosevelt Drainage Tunnel level.

The School Section, which has been a heavy producer, is now under lease to your company. It has been equipped to operate economically. The Midland Terminal Railroad has constructed a switch which will permit direct loading in cars. This area, containing 120 acres, has good possibilities for ore.

Total production, Cresson Consolidated Gold Mining & Milling Co., Colorado, 1903 to December 31, 1928

Period	Dry short tons	Gross value	Freight and treatment	Net value	Average gross value per ton	Average net value per ton	Dividends
1903 to Aug. 31, 1927-----	1, 540, 716	\$29, 996, 852. 95	\$8, 634, 096. 25	\$21, 362, 756. 70	\$19. 46	\$13. 86	\$11, 637, 072. 50
Sept. 1, 1927, to Aug. 31, 1928:							
Company ore-----	106, 041	977, 158. 99	408, 740. 07	568, 418. 92	9. 21	5. 36	-----
Lessee ore-----	708	2, 147. 97	1, 739. 13	408. 84	3. 03	. 57	-----
1903 to Aug. 31, 1928-----	1, 647, 465	30, 976, 159. 91	9, 044, 575. 45	21, 931, 584. 46	18. 81	13. 32	12, 125, 072. 50
1903 to Dec. 31, 1928-----	1, 691, 661	31, 284, 586. 35	-----	-----	-----	-----	12, 173, 872. 50

At the Elkton 1,190 feet of development work was done, and 15,800 tons of ore was shipped. The Jo Dandy shaft was reopened in March, and development started in May, 1928; drifts totaled 325 feet, crosscuts 259 feet, and raises 124 feet. The Queen Exploration Co. in 1928 did 760 feet of raises, 170 feet of crosscuts, 760 feet of drifts, and 215 feet of diamond drilling; the company shipped 26,080 tons of ore from the Queen group.

Beacon Hill.—Producing mines were the El Paso and the Gold Dollar. Most of the production from the El Paso came from the open-pit workings of the Hartman & Clifford lease.

Bull Hill.—Producing mines on Bull Hill were the Big Banta, Blue Bird dump, Dante, Dexter, Gold Pinnacle, Los Angeles, Modoc dump, Orpha May, Rubie dump, and Trail. The Dante was operated by the Cresson company. At the Dexter 200 feet of development was done. The Gold Pinnacle was held under bond and lease by the Mexican Gold & Silver Mining Co.; the company drove 831 feet of drifts and crosscuts and shipped 1,083 tons of ore. The Stratton Lease operated the Orpha May for two months and the Los Angeles throughout the year. The Los Angeles was worked through the Last Dollar shaft.

Between Altman and Goldfield.—Producing mines between Altman and Goldfield were the Acacia, Deadwood, Delmonico, Empire Lee, Findley dump, Free Coinage, Pharmacist, Theresa, Victor dump, and Vindicator.

Battle Mountain.—Producing mines were the Granite, Portland-Independence-Last Dollar group, and Rose Nicol. Development work at the Granite totaled 2,350 feet; production amounted to 6,180 tons.

The thirty-fifth annual report of the Portland Gold Mining Co., for 1928 (dated February 18, 1929), says:

Although our cash balance decreased materially during the period, I feel that the outlook of your company is far brighter than it was a year ago.

When the new management took charge of the Portland late in February last, we had no ore reserves of consequence. One stope on 2,600 and one on the 2,700 foot level constituted our available supply of ore. Leases had been granted on the supporting pillars of ore on 2,700 and 2,900.

We had two policies to choose from. One was to pull the stopes then open, remove the pillars, and then close the mine. The other was to use such cash as was available in an effort to find new ore. We decided to terminate the pillar leases and start an intensive development campaign.

As a result of this policy, we have opened several new areas which are discussed in detail in the mine superintendent's report. An important point in connection with these new finds is that the very existence of the ore located on the 1,700, 1,800, and 2,100 foot levels makes it logical to believe that further developments there and on the levels above and below will show the upward extension of the ore bodies heretofore mined on the 2,700 and 2,900 foot levels.

Our progress may seem slow to the uninitiated, and under the method of mining necessarily employed is slow, as is indicated by the fact that we will about the middle of February begin to pull the ore from the first stope which we will have completed. The production we have had during the year has come from the two old stopes mentioned above and from shrinkage from the new ones which are in the course of being filled with broken ore.

On account of this shortage of ore we were compelled to close the mill on November 30. Handling so small a tonnage in so large a mill made the costs prohibitively high. The resulting condition was greatly relieved by a marked decrease in freight rates and treatment charges in the Golden Cycle, where we are now shipping.

During the year we had the tailings ponds at the mill tested as to value. We found they averaged 66 cents per ton and that much of the value could be recovered by flotation. There are some three million tons of these tailings and they may constitute an asset of the company if we can arrange to treat them some time in the future.

ACTIVITY AT THE INDEPENDENCE MINE

Giving consideration to previously submitted reports of capable mining engineers and respecting the convictions held by former directors of the company, a thorough and convincing test was made in connection with reported values in the Captain area and territory of the caved area north of the Independence shaft from the "A" level to the surface. After breaking many thousand tons of this supposed mill ore, which was mined from the intersection of the big producing Independence veins, the product was subjected to various sizing to determine if a profitable grade might result. The entire production was first put through the mill. Secondly, over a 3-inch grizzly—the reject to dumps and the undersize to mill, and as a final operation, over a $\frac{3}{4}$ -inch screen. The reject from this operation was sold for crushed rock and the fines delivered to mill. After approximately seven months' operation during which entire time the value of ore produced was wholly disappointing, the Independence mine was closed. Applications for leases on various blocks have been made by miners of the district. These leases have been granted.

EXPLORATION WORK IN PORTLAND MINE

1,700-foot level.—The three main drives on this level constitute the Strong, the Wisconsin, and the Lee drifts and crosscuts. On these three drives ore has been opened in the Strong and Wisconsin country. The Strong area, being practically directly under the famous Captain country, shows some very good ore, and two stopes are being worked at the present time in this area. The Wisconsin vein has been developed north to a point connecting with the old work on the Wisconsin South drift, and a stope is being carried up on this vein. Indications above show that this stope should increase in length as well as in value in its upward extension. The Strong North drift and the Wisconsin North drift both encountered some bad air, and due to this condition we were forced to put in a ventilating system which materially helped the general conditions. At the present time connections have been made with the Captain No. 9 East crosscut in the Strong country, and with the Page winze in the Wisconsin country, which give us very good air in both places. The Lee south drift was run to prospect the approximate location of the downward extension of the famous Lee chimney of the upper levels. This drift at the present time is following the contact and is showing some indication of value, although none of commercial value at present. A total of 2,444 feet of drifting and 221½ feet of crosscutting was completed on this level.

1,800-foot level.—Five hundred fifty-nine feet of work was completed on this level which is credited as follows: 445 feet of crosscutting and 114 feet of drifting. This work is being done to locate the downward extension of our Strong ore chutes on 1,700. Some values have been encountered in this work, and several veins have been cut showing encouraging values.

2,000 foot level.—Four hundred thirty-two feet of work was completed on this level, credited as follows: 390 feet of drifting and 42 feet of crosscutting. This work opened our Lee No. 5 vein. Some stoping was done on this vein and some encouraging values encountered.

2,100-foot level.—Eleven hundred twenty-three feet of work was completed on this level, which was credited as follows: 749 feet of drifting, 367 feet of crosscutting and 7 feet in winzing. The main drift on this level was driven on the Lost Anna vein and values were encountered and stoping started. This is approximately 300 feet below our 18th level, which showed some very good values. Work has also been started to cut our Strong country. This work has encountered some very good ore.

2,300-foot level.—A total of 245 feet of work was completed on this level, which was credited as follows: 217 feet of drifting and 28 feet of crosscutting. This work followed a phonolite dyke to the north of 2,300 East No. 1 stope and no ore was encountered.

2,400-foot level.—A total of 337 feet of work was completed, which is credited as follows: 332 feet of crosscutting and 5 feet of drifting. One crosscut was driven west from our 2,400 East No. 1 stope with a possibility of picking up the upward extension of the famous 2,700 East No. 1 ore chute. No values were encountered. The other crosscut was driven east from the No. 1 vein to locate the extension of our 2,700 East No. 3 ore chute. No values were encountered.

2,600-foot level.—Thirteen hundred seventeen feet of work was completed, which is credited as follows: 538 feet of drifting, 665 feet of crosscutting, and 114 feet of raising. A stope was opened south of our West No. 1 stope. This stope has been taken through to 2,400. A crosscut was run east from our East No. 1 vein for a distance of 200 feet. No values were encountered. Crosscutting and drifting has been done directly over our 2,700 East No. 3 stope, and although some values were encountered, no ore of commercial grade resulted.

2,700-foot level.—Nine hundred thirty-four feet of work was completed, which was credited as follows: 504 feet of drifting, 400 feet of crosscutting, and 30 feet of winzing. Due to the above work the 2,700 East No. 3 stope was opened, which shows a very good grade of ore. This stope at present is about 70 feet long and over a hundred feet high, with the back still in ore. The 2,700 West No. 1 vein had been opened for a distance of 275 feet. This entire amount has been cut out and is on timbers. The values on the level were very encouraging. The values in the back of the stope are low. A winze was sunk on the vein for 20 feet, showing some very good ore in the ends. The values in the bottom are low. The 2,700 East No. 1 stope was taken through to 2,600 and has been pulled. This stope furnished a very good grade of ore.

2,900-foot level.—Eleven hundred ninety-five feet of work was completed, which is credited as follows: 587 feet of drifting, 415 feet of crosscutting, and 193 feet of raising. Two stopes have been opened, which show a very good grade of ore. Most of the crosscutting and drifting was completed in the West No. 1 country with rather discouraging results. Some low values were encountered which may necessitate further work. The downward extension of the 2,700 East No. 3 stope has been located, and it is producing some very good ore.

3,000-foot level.—Two hundred fifteen feet of work was completed, which is credited as follows: 114 feet of drifting and 101 feet of crosscutting. The downward extension of the 2,700 East No. 3 ore chute was not located; although some values were encountered, no ore of commercial grade resulted.

Production.—The Portland mine produced 9,652 dry tons of company ore and 86,658 dry tons mill dirt. The lessees shipped 5,628 dry tons. A total production of 101,938 dry tons.

Water.—We pumped 417,017,600 gallons of water from an average depth of 1,000 feet at a cost of \$27,143.44. This cost was divided as follows: Labor, \$5,570.03; power, \$21,573.41.

All equipment is in first-class condition and the electrifying of our No. 2 hoist, which is to be completed in the near future, should make a considerable saving in the operation of our No. 2 plant. At the present time this is the only contemplated material change.

LAST DOLLAR MINE

The company shipped 2,911 dry tons. The lessees shipped 5,508 dry tons, making a total production of 8,419 dry tons. The Stratton Estate Lease is still operating through this shaft.

The Portland Gold Mining Co. of Wyoming

OPERATION FOR THE YEAR 1928

Gross value of ore mined and shipped-----	\$200, 012. 72
Gross value recovered by mill-----	473, 839. 80
	673, 852. 52
Net cost of mining and milling-----	865, 646. 08
Loss from operation of mines and mill-----	191, 793. 56

Profit and loss for the year 1928:

Loss from operations-----		\$191,793.56
Other income—		
Interest-----	\$2,241.58	
Discount and exchange-----	505.84	
Dividends-----	2.50	
		<u>2,749.92</u>

Loss before depreciation and depletion-----		189,043.64
Depreciation-----	63,129.48	
Depletion-----	37,800.96	
		<u>100,930.44</u>

Final loss—to surplus-----		<u>289,974.08</u>
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Surplus:

Balance January 1, 1928-----		699,807.72
Profit on sale of Last Effort claim-----	2,236.83	
Profit on sale of Gold Sovereign Mine & Tunnel Co. stock-----	56.59	
		<u>2,293.42</u>

		702,101.14
Loss for the year 1928-----	289,974.08	
Adjustment of taxes to accrual basis-----	15,121.75	
		<u>305,095.83</u>

Balance December 31, 1928-----		<u>397,005.31</u>
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CASH RECEIPTS AND DISBURSEMENTS

Balance January 1, 1928-----		159,326.79
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Receipts:

From operation of mines and mill-----	\$562,202.30	
Royalties-----	14,994.82	
Bills and accounts receivable-----	30,445.61	
Sale of Last Effort claim-----	20,000.00	
Altman Water Co. bond redeemed-----	1,000.00	
Interest-----	2,241.58	
Insurance premiums refunded-----	537.59	
Dividends received-----	2.50	
Sale of Gold Sovereign Mine & Tunnel Co. stock-----	525.64	
Sale of stores and supplies-----	16.99	
		<u>631,967.03</u>

791,293.82

Disbursements:

Vouchers and pay checks-----		750,914.80
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Balance December 31, 1928-----		40,379.02
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BALANCE SHEET, JANUARY 1, 1929

Assets:

Cash-----		40,379.02
Accounts receivable-----		27,876.04
Stores and supplies-----		18,522.23
Property—		
Mines-----	\$4,215,163.79	
Mill-----	1,107,704.10	
		<u>5,322,867.89</u>
Permanent equipment-----		651,769.69
Investment in other companies-----		78,589.01
Prepaid insurance-----		7,720.98
		<u>6,147,724.86</u>

Liabilities:

Bills payable—unsecured	\$26,231.45	
Accrued general taxes	13,121.29	
Accounts payable	12,338.33	
		\$51,691.07

Reserves:

For depreciation	1,312,362.92	
For depletion	1,386,665.56	
		2,699,028.48

Capital:

Capital stock	3,000,000.00	
Surplus	397,005.31	
		3,397,005.31
		6,147,724.86

Statement of ore production of the Portland properties from April 1, 1894, to December 31, 1928

	Net tons	Gross value
From Apr. 1, 1894, to Dec. 31, 1927	5,960,413	\$60,479,834.11
From Jan. 1, 1928, to Dec. 31, 1928	159,304	673,852.52
Grand total of ore production to date	6,119,717	61,153,686.63

Total dividends paid to Jan. 1, 1929, \$11,992,080.

Statement of all work on Portland properties to January 1, 1929

	Totals during 1928, in feet	Total, previous years, in feet	Grand total, in feet
Drifts	5,781.50	167,897.00	173,678.50
Crosscuts	2,908.00	152,788.50	155,696.50
Raises	307.00	33,412.00	33,719.00
Winzes	37.00	6,876.50	6,913.50
Shafts		13,818.50	13,818.50
	9,033.50	374,792.50	383,826.00

Total for Portland mine, 72 miles, 3,666 feet.

Total (not included above) for Independence mine, 17 miles, 1,917.5 feet.

United Gold Mines Co.—The annual report of the United Gold Mines Co., an operating and holding company for property scattered throughout the Cripple Creek district, says:

The ore developed on the company's property at the present time is as follows:

The Bonanza has stopes on the New Market vein which will permit mining at profit for about one year. The Vindicator has proven ore for about the same period, but the shipping ore is such a small part of the rock broken that the profits are not high. The Rose N'col-Trail has very little developed ore, but the work being done is in a favorable country. The Fairview ore is not large, but all rock broken may be shipped.

The lessees have some good ore, especially the Cain Lease on the Solomon. Some of the lessees in the Vindicator also have good ore in small quantities.

Development work on different parts of the company's property is being done with encouraging results.

Operating statement, United Gold Mines Co., 1928

Receipts:

Company ore sales	\$359, 129. 06
Royalties	62, 103. 81
Miscellaneous earnings	1, 403. 81
No. 1 Screened Rock plant	2, 341. 11
No. 2 Screened Rock plant	1, 446. 14
Interest	2, 314. 85
	428, 738. 78

Expenses:

Cripple Creek office	2, 201. 09
Colorado Springs office	774. 26
Officers' salaries	5, 100. 00
Fairview Lease mining expense	7, 813. 10
Bonanza mining expense	112, 029. 07
Trail mining expense	131, 851. 01
Vindicator mining expense	104, 519. 05
Mine owners' association	576. 00
Fire insurance	60. 00
Taxes	7, 656. 96
Legal expense	10, 000. 00
Federal taxes	8, 414. 57
Miscellaneous operation	1, 986. 86
Balance net operating profit	35, 756. 81
	428, 738. 78

Profit and loss—recapitulation—United Gold Mines Co., 1928

Bad debts charged	\$7, 388. 63	
Operating accounts	392, 981. 97	
Dividends	100, 000. 00	
Depletion	29, 610. 41	
Depreciation	1, 951. 37	
Mine owners' association suspense	117. 00	
Bad debts collected		\$6, 383. 14
Income accounts		428, 738. 78
Fire insurance suspense		211. 43
Debit balance		87, 716. 03
	523, 049. 38	523, 049. 38

Total production of United Gold Mines property to December 31, 1928

	Net tons	Gross value
Ore mined before consolidation	26, 310	\$456, 806. 19
Production under operations of the United Gold Mines Co.	733, 421	9, 180, 104. 26
Total to Dec. 31, 1928	759, 731	9, 636, 910. 45

Production of the United Gold Mines Co. in 1928

Group	Net tons	Gross value	Royalties received	Company ore cash receipts	Lessees' receipts	Average gross value per ton
Axtel.....	1,701.938	\$36,875.37	\$3,258.06	\$14,123.79	\$7,426.92	\$21.67
Bonanza.....	8,997.073	187,865.07	583.41	133,729.18	565.50	20.88
Coriolanus.....	742.964	3,613.63	142.24	-----	1,198.30	4.87
Deadwood.....	1,957.275	7,333.90	392.51	-----	1,801.67	3.74
Climax.....	26.356	21.09	-----	-----	-----	.80
Ida May.....	105.100	500.12	25.37	-----	136.50	4.76
Montrose.....	21.559	43.12	-----	-----	-----	2.00
Poorman.....	72.533	407.33	19.36	-----	170.17	5.61
Rose Nicol.....	32,679.542	295,683.50	3,413.10	168,800.21	3,658.53	9.04
Theresa.....	7,640.624	97,160.73	26,533.54	-----	34,318.06	12.71
Vindicator.....	21,887.442	125,219.58	26,117.78	-----	31,165.34	5.72
W. P. H.....	4,258.709	42,880.63	2,095.14	-----	19,526.69	10.07
Vindicator Co.....	17,534.987	88,779.59	-----	42,475.88	-----	5.06
	97,626.102	886,383.66	62,580.51	359,129.06	99,967.68	9.08
Less royalties paid.....	-----	-----	476.70	-----	-----	-----
	97,626.102	886,383.66	62,103.81	359,129.06	99,967.68	9.08

Development of the United Gold Mines Co. in 1928

	Feet
Vindicator lessees.....	3,455
Rose Nicol group.....	2,880
Bonanza.....	904
Drainage tunnel.....	420
Fairview.....	185
Last Effort.....	1,089
Pauper-Findley.....	12
Vindicator.....	1,217
	10,162

GOLD AND SILVER ¹

(GENERAL REPORT)

By J. P. DUNLOP

DOMESTIC PRODUCTION

Approximate distribution of gold and silver produced in the United States in 1928, by producing States

[Figures supplied by the U. S. Bureau of the Mint]

State	Gold		Silver	
	Fine ounces	Value ¹	Fine ounces	Value ²
Alaska.....	330,604	\$6,834,200	486,859	\$284,812
Arizona.....	189,519	3,917,700	6,564,933	3,840,486
California.....	513,249	10,609,800	1,467,088	858,246
Colorado.....	258,564	5,345,000	4,384,072	2,564,682
Georgia.....	34	700	5	3
Idaho.....	20,351	420,700	8,949,716	5,235,584
Illinois.....			2,677	1,566
Michigan.....			18,707	10,944
Missouri.....			158,280	92,594
Montana.....	59,661	1,233,300	10,681,675	6,248,780
Nevada.....	177,730	3,674,000	5,312,610	3,107,877
New Mexico.....	34,961	722,700	925,449	541,388
North Carolina.....	131	2,700	19,141	11,197
Oregon.....	11,865	245,300	31,858	18,637
Pennsylvania.....	987	20,400	7,428	4,345
Philippine Islands.....	88,531	1,830,100	36,503	21,354
South Carolina.....	10	200		
South Dakota.....	318,095	6,575,600	91,697	53,643
Tennessee.....	537	11,100	75,907	44,406
Texas.....	556	11,500	1,394,665	815,879
Utah.....	211,418	4,370,400	17,749,317	10,383,350
Washington.....	16,414	339,300	103,907	60,786
Wyoming.....	34	700	13	8
	2,233,251	46,165,400	58,462,507	34,200,567

¹ Gold valued at \$20.67+ a fine ounce.

² Silver valued at 58.5 cents a fine ounce. Average New York price of bar silver.

The figures in the preceding table were obtained through cooperation between the United States Bureau of the Mint and the Bureau of Mines and were agreed upon after conference and adjustment between the two bureaus. They are therefore final for both.

The totals are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by means of information collected by the Bureau of Mines directly from the producing mines and tabulated for the mine reports discussed

later. The data for the total production and in part for the distribution are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ore and matte exported for reduction. The last item is small.

*Increase or decrease in production of gold and silver in the United States in 1928,
by States*

State	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value
Alaska.....	+44,306	+\$915,900	-119,270	-\$58,863
Arizona.....	-13,569	-280,500	-36,534	-\$9,454
California.....	-51,732	-1,069,400	-90,724	-25,033
Colorado.....	-547	-11,300	+442,721	+329,936
Georgia.....	+19	+400	+1	+1
Idaho.....	+5,142	+106,300	+21,097	+173,057
Illinois.....			+1,177	+716
Michigan.....			-33,035	-18,394
Missouri.....			+71,062	+43,141
Montana.....	+3,585	+74,100	-1,128,090	-447,357
Nevada.....	+28,285	+584,700	-60,290	+61,443
New Mexico.....	+8,863	+183,200	+170,571	+113,372
North Carolina.....	+97	+2,000	+19,007	+11,121
Oregon.....	-2,560	-52,900	-9,815	-4,992
Pennsylvania.....	+861	+17,800	+5,129	+3,042
Philippine Islands.....	+8,659	+179,000	-3,739	-1,463
South Carolina.....	+10	+200		
South Dakota.....	-4,586	-94,800	-3,426	-292
Tennessee.....	+111	+2,300	-6,368	-2,244
Texas.....	+232	+4,800	+451,694	+281,215
Utah.....	+11,900	+246,000	-1,604,441	-590,231
Vermont.....			-938	-532
Washington.....	-2,984	-61,700	-57,736	-30,866
Wyoming.....	+34	+700	+13	+8
	+36,126	+746,800	-1,971,934	-65,761

Domestic smelters and refiners recovered 690,574 fine ounces of gold and 78,869,111 fine ounces of silver from foreign ores and bullion, a decrease of 5,868 ounces of gold and an increase of 4,206,232 ounces of silver compared with the corresponding figures for 1927. The foreign ores and bullion came from many sources, but, as usual in recent years, mainly from Mexico, Canada, and Peru.

The value of the new gold used in the arts and manufactures in the United States in 1928 was \$31,569,500, or 68 per cent of the domestic production of the United States; compared with \$32,857,491 in 1927. The quantity of new silver used for such purposes was 24,931,283 fine ounces, or 43 per cent of the total domestic output, compared with 28,493,290 ounces in 1927. In addition to the new gold used in the arts and industries in 1928, \$27,511,159 in gold recovered from waste material was also utilized. The total quantity of silver (new and old) used in the arts and manufactures was 35,547,663 ounces, or about 3,101,000 ounces less than in 1927. It is estimated that about 8,000,000 ounces of silver was used in the photographic and chemical industries. In addition to the gold and silver derived from foreign and domestic ore and bullion, \$22,643,969 in gold and 9,461,291 ounces of silver were recovered from old or obsolete jewelry, silverware, dental waste, and other material. Most of the silver recovered is now handled by private refineries.

Gold and silver produced in the United States, 1792-1928

[The estimate for 1792-1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint]

Period	Gold		Silver	
	Fine ounces	Value	Fine ounces	Value
1792-1847 ¹	1, 186, 977	\$24, 537, 000	309, 500	\$404, 500
1848-1872.....	58, 279, 781	1, 204, 750, 000	118, 568, 200	157, 749, 900
1873-1928.....	157, 520, 083	3, 256, 229, 100	2, 936, 319, 859	2, 294, 445, 434
	216, 986, 841	4, 485, 516, 100	3, 055, 197, 559	2, 452, 599, 834

¹ A careful investigation by Philip B. Bekeart (Soc. California Pioneers Quarterly, Sept. 30, 1924) appears to have definitely fixed Jan. 19, 1848, as the date of the discovery of gold by James W. Marshall at Sutters Mill, Coloma, Eldorado County, Calif., and to have shown that the flakes (not a nugget) found by Marshall are now in the National Museum, Washington, D. C.

The average commercial value per fine ounce of silver for the total recorded domestic production is \$0.803.

PRICES OF SILVER

The average monthly prices of fine bar silver in New York in 1928 were as follows:

Price of silver per fine ounce in 1928, by months

January.....	\$0. 57450	August.....	\$0. 59191
February.....	. 57328	September.....	. 57849
March.....	. 57557	October.....	. 58398
April.....	. 57707	November.....	. 58266
May.....	. 60611	December.....	. 57647
June.....	. 60332		
July.....	. 59525	Average.....	. 58488

The yearly price of silver trended downward steadily, in the main, from \$1.337 and \$1.339 in 1865 and 1866 to a low point of \$0.507 in 1915. Considering the world trade and political situation during the last five years, the price has been remarkably stable. In 1928 the spread in the average monthly prices was only \$0.03283 an ounce and the highest monthly average price was that for May. The average prices in 1929 will probably approximate 6 cents lower than those for 1928, as the price of silver was decreasing to about 50 cents an ounce in the fall of 1929.

Price of silver per fine ounce, 1919-1928 ²

1919.....	\$1. 12	1924.....	\$0. 670
1920.....	1. 09	1925.....	. 694
1921.....	1. 00	1926.....	. 624
1922.....	1. 00	1927.....	. 567
1923.....	. 82	1928.....	. 585

² New York dealers' buying price for 1919; average buying price of silver from domestic mines for 1920 to June 2, 1923; average New York price for all silver after that period.

IMPORTS AND EXPORTS ³

Value of gold and silver imported into and exported from the United States, 1927 and 1928, by classes

	Imports	Exports	Excess of—	
			Imports	Exports
1927				
Gold:				
Contained in domestic ore and base bullion		\$330,246		\$330,246
Contained in foreign ore and base bullion	\$18,110,866	2,350	\$18,108,516	
Domestic bullion refined		54,608,475		54,608,475
Foreign bullion refined	87,262,450	21	87,262,429	
United States coin	71,001,720	146,302,604		75,300,884
Foreign coin	31,160,159	211,404	30,948,755	
	207,535,195	201,455,100	136,319,700	130,239,605
Excess imports over exports			6,080,095	
Silver:				
Contained in domestic ore and base bullion		70,157		70,157
Contained in foreign ore and base bullion	32,056,952		32,056,952	
Domestic bullion refined	31,795	59,848,110		59,816,315
Foreign bullion refined	20,745,549	13,200,447	7,545,102	
United States coin	902,909	396,482	506,427	
Foreign coin	1,336,712	2,109,584		772,872
	55,073,917	75,624,780	40,108,481	60,659,344
Excess exports over imports				20,550,863
1928				
Gold:				
Contained in domestic ore and base bullion		268,517		268,517
Contained in foreign ore and base bullion	14,499,910		14,499,910	
Domestic bullion refined		411,892,524		411,892,524
Foreign bullion refined	102,455,023	5,200,226	97,254,797	
United States coin	47,870,221	143,225,401		95,355,180
Foreign coin	4,072,153	172,673	3,899,480	
	168,897,307	560,759,341	115,654,187	507,516,221
Excess exports over imports				391,862,034
Silver:				
Contained in domestic ore and base bullion		51,769		51,769
Contained in foreign ore and base bullion	37,331,651		37,331,651	
Domestic bullion refined		64,051,823		64,051,823
Foreign bullion refined	28,476,770	20,620,905	7,855,865	
United States coin	1,622,489	225,210	1,397,279	
Foreign coin	686,419	2,432,309		1,745,890
	68,117,329	87,382,016	46,584,795	65,849,482
Excess exports over imports				19,264,687

DOMESTIC SUPPLY

The total excess of imports of gold over exports for the period 1916 to 1928 was \$1,570,500,000. The only years since 1916 in which exports of gold exceeded imports were: 1919, when the excess was \$292,000,000; 1925, when the excess was \$134,000,000; and 1928, when the excess was \$391,862,000. The large gain in the domestic supply of gold is best illustrated by the following figures, which show the excess of imports over exports for each of these years: In 1916, \$530,000,000; in 1917, \$180,000,000; in 1918, \$21,000,000; in 1920, \$95,000,000; in 1921, \$667,000,000; in 1922, \$238,000,000; in 1923, \$294,000,000; in 1924, \$258,000,000; in 1926, \$98,000,000; and in 1927, \$6,000,000.

The domestic supply of new gold comes chiefly from dry and siliceous ore and from placer gravel worked largely by dredges. These

³ Figures on imports and exports compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

two sources yielded 90.2 per cent of the domestic gold in 1915, 78.5 per cent in 1926, 76.6 per cent in 1927, and 75.1 per cent in 1928. Considerable gold is recovered also from the refining of copper bullion, especially from copper ore produced at mines in Arizona, Nevada, and Utah. The tendency has been for the proportionate output from gold ore to decrease with declining yield from many of the principal gold camps and for that from copper ore to increase; the result is a general net decline in total yield of gold due to the preponderant proportion of the output that comes from placers and from gold and gold-silver ores. The proportionate output of gold from copper ore was 7.2 per cent in 1915, 16.4 per cent in 1926, 17.4 per cent in 1927, and 19.3 per cent in 1928.

In 1928 the domestic supply of new silver came chiefly from lead-zinc ore, copper ore, lead ore, and dry and siliceous silver and silver-gold ores, in the proportion of 28.01, 25.46, 23.18, and 19.25 per cent, respectively, compared with 22.85, 24.41, 26.44, and 19.75 per cent in 1927. In 1915 dry and siliceous ore yielded 36 per cent of the silver, copper ore 26 per cent, lead ore 27 per cent, and lead-zinc ore only 9 per cent. Thus the largest gain in the output of silver has been from lead-zinc ore and the greatest loss from dry and siliceous ore.

WORLD PRODUCTION

GOLD

The estimated value of the gold produced in the world from 1860 to 1928, inclusive, is \$16,687,348,400. In 1928 the estimated production of the world is recorded as \$406,336,500, an increase of about \$4,646,600 over that for 1927. There were increases of about \$1,601,000 in 1927, \$6,831,000 in 1926, \$25,607,000 in 1924, and \$48,400,000 in 1923. There was a decrease of \$202,000 in 1925 and successive annual decreases from 1915 to 1922.

In 1928 the production of the United States increased \$746,800; that of South Africa about \$4,217,900; that of Russia \$2,874,000; and that of Canada \$781,500. Large decreases in 1928 were: Mexico, \$539,000; Chile, \$644,800; Colombia, \$666,400; Peru, \$532,400; and Australasia, \$1,172,000.

In a recent publication⁴ issued by the Bureau of Mines the world production of gold from 1493 to 1927, inclusive, is estimated as approximately 1,003,560,000 ounces, of which 15 per cent was produced from 1493 to 1850, inclusive, 33.5 per cent from 1851 to 1900, and 51.5 per cent from 1901 to 1927. Of this total North America produced 28 per cent, South America 12.4 per cent, Asia 11.2 per cent, Africa 26.9 per cent, and Australasia 16.8 per cent.

For the last eight years the mines in the Union of South Africa (Transvaal, Natal, and Cape Colony) have been yielding more than half the world's supply of gold and were the largest contributors to the increased output in 1927 and 1928. The gold production of Canada has increased. Russia is recovering from many years of output, small compared with its resources. The yield of gold from Africa, Canada, and Russia is likely to increase slowly; the output from many countries, however, has been decreasing, so that on the whole a greatly increased world output is not likely in the immediate future, and there may be declines in some years.

⁴ Ridgway, Robert H., Summarized Data of Gold Production: Econ. Paper 6, Bureau of Mines, 1929, 63 pp.

The following table shows the output of gold by countries, as given by the Bureau of the Mint, with slight changes resulting from late information.

World production of gold, 1923-1928

Country	1923	1924	1925	1926	1927	1928
North America:						
Canada.....	\$25, 495, 400	\$31, 532, 400	\$35, 880, 800	\$36, 263, 100	\$38, 300, 500	\$39, 082, 000
Central America.....	2, 000, 000	1, 800, 000	2, 000, 000	1, 800, 000	1, 500, 000	1, 250, 000
Mexico.....	16, 158, 400	16, 480, 100	16, 309, 900	15, 972, 300	14, 990, 700	14, 451, 700
United States.....	51, 734, 000	52, 277, 000	49, 860, 200	48, 269, 600	45, 418, 600	46, 165, 400
South America:						
Argentina.....	80, 000	60, 000	55, 000	50, 000	20, 000	20, 000
Bolivia.....	8, 400	19, 900	8, 000	6, 900	5, 000	10, 500
Brazil.....	2, 990, 700	2, 990, 700	2, 243, 000	2, 110, 800	2, 120, 100	2, 069, 600
Chile.....	1, 331, 200	1, 400, 000	1, 265, 500	1, 222, 400	1, 240, 300	595, 500
Colombia.....	5, 700, 000	2, 000, 000	1, 582, 400	1, 481, 300	1, 500, 000	833, 600
Ecuador.....	877, 600	800, 000	900, 000	1, 291, 700	1, 328, 000	1, 541, 600
Guiana—						
British.....	168, 900	131, 000	188, 300	134, 700	118, 100	110, 100
French.....	922, 500	1, 312, 600	831, 400	935, 100	999, 600	939, 700
Netherland.....	263, 200	214, 000	204, 700	155, 600	158, 800	113, 700
Peru.....	2, 488, 300	2, 459, 000	2, 433, 800	2, 485, 600	1, 915, 400	1, 383, 000
Uruguay.....	200	200				
Venezuela.....	358, 900	358, 900	631, 400	631, 300	813, 800	997, 600
Europe:						
Austria.....	15, 300	40, 500	38, 500	27, 200	2, 700	6, 600
Czechoslovakia.....	69, 100	185, 100	156, 800	159, 500	155, 000	143, 500
France.....	350, 200	409, 400	701, 800	868, 400	930, 400	930, 400
Germany.....	132, 900	132, 900	120, 900	107, 600	119, 600	119, 600
Great Britain.....						2, 700
Greece.....	8, 600	8, 000			10, 000	10, 000
Italy.....	25, 200	31, 900	39, 900	35, 200	44, 500	33, 200
Rumania.....	996, 900	871, 300	827, 400	1, 150, 400	1, 367, 800	1, 294, 600
Russia.....	5, 181, 900	19, 805, 100	20, 364, 900	20, 509, 700	21, 931, 800	24, 806, 200
Spain.....	18, 700	20, 000	20, 000	20, 000	20, 000	15, 000
Sweden.....				305, 700	305, 700	289, 400
Yugoslavia.....	126, 900	161, 500	156, 800	214, 700	256, 500	292, 400
Asia:						
China.....	1, 850, 100	2, 218, 100	2, 218, 100	2, 273, 900	2, 067, 200	2, 067, 200
Chosen.....	2, 510, 200	2, 772, 700	3, 035, 100	3, 940, 500	3, 706, 800	3, 439, 400
East Indies—						
British.....	600, 000	500, 000	500, 000	400, 000		
Netherland.....	2, 388, 600	2, 571, 300	2, 743, 500	2, 384, 600	2, 337, 400	2, 278, 900
Federated Malay States.....	190, 000	309, 200	292, 400	299, 200	221, 300	386, 400
India, British.....	8, 729, 900	8, 193, 200	8, 140, 700	7, 937, 400	7, 943, 500	7, 773, 800
Indo-China.....	128, 300	7, 200	7, 200	6, 600	6, 600	5, 300
Japan.....	5, 111, 700	5, 054, 300	6, 557, 800	6, 364, 100	6, 383, 900	6, 383, 900
Sarawak.....	20, 800	17, 700	14, 700	5, 000	5, 000	4, 100
Taiwan.....	453, 900	178, 800	186, 800	186, 800	303, 700	303, 700
Turkey.....	29, 900	19, 300	19, 300	19, 900	19, 900	18, 600
Africa	209, 954, 000	219, 579, 700	218, 759, 600	226, 580, 500	228, 870, 700	233, 088, 600
Australasia	18, 382, 600	16, 536, 800	13, 961, 800	13, 481, 600	14, 251, 000	13, 079, 000
	367, 853, 400	393, 460, 800	393, 258, 400	400, 088, 900	401, 689, 900	406, 336, 500

¹ Includes Philippine Islands as given on p. 873.

SILVER

The increase in the world production of silver in 1928 was 3,280,600 ounces. The largest increases were: Mexico, 3,963,000 ounces; Peru, 3,312,000 ounces; Burma, 1,400,000 ounces; and Bolivia, 236,000 ounces. The largest decreases were: United States, 1,972,000 ounces; Chile, 1,463,000 ounces; Canada, 800,000 ounces; Central America, 596,000 ounces; and Spain, 530,000 ounces. The United States and Canada produced 31 per cent of the total (33 per cent in 1927); Mexico, Central America, and South America produced nearly 55 per cent; and all other countries—mainly Australasia, Burma, Japan, and Spain—produced only about 14 per cent.

Most of the world output of silver is produced or refined in the United States, but a large part of it is consumed in Europe, India, and China.

World production of silver, 1923-1928, in fine ounces

Country	1923	1924	1925	1926	1927	1928
North America:						
Canada.....	17,754,700	19,736,300	20,229,000	22,371,900	22,736,700	21,936,400
Central America.....	2,500,000	2,686,200	2,700,900	3,499,100	3,154,000	2,558,500
Mexico.....	90,859,100	91,486,100	92,885,500	98,291,200	104,573,900	108,537,300
United States.....	73,335,200	65,407,200	66,155,400	62,718,700	60,434,400	58,462,500
South America:						
Argentina.....		20,000	18,000	15,000	15,000	15,000
Bolivia.....	5,212,800	4,857,600	4,340,500	5,834,000	5,402,800	5,638,800
Brazil.....	28,600	28,600	1,800	20,700	15,600	25,600
Chile.....	3,337,500	3,357,700	3,261,700	2,876,900	2,900,000	1,436,700
Colombia.....	3,100	2,900	2,900	126,000	131,400	68,200
Ecuador.....	75,000	70,000	70,000	80,000	87,600	79,800
Guiana.....	8,500	8,700	8,500	8,000	8,000	7,500
Peru.....	18,654,800	18,717,100	19,917,400	21,499,800	18,295,400	21,607,700
Venezuela.....	2,700	2,700	3,200	3,200	3,200	4,000
Europe:						
Austria.....	14,200	28,700	23,900	14,100	9,700	18,900
Czechoslovakia.....	702,300	732,500	707,300	765,500	750,000	767,700
France.....	213,000	147,900	352,000	261,800	308,600	308,600
Germany.....	3,753,000	3,753,000	4,780,400	5,358,900	5,293,400	5,293,400
Great Britain.....	34,600	31,100	32,400	41,300	46,700	32,800
Greece.....	184,100	160,700	254,300	254,300	241,100	241,100
Italy.....	385,800	497,000	320,800	519,400	537,100	514,400
Norway.....	297,900	424,400	504,700	308,600	315,100	334,600
Poland.....		192,900	212,200	271,700	250,000	235,100
Rumania.....	84,800	72,200	76,600	93,700	140,700	100,000
Russia.....	192,900	250,000	250,000	250,000	321,500	380,000
Spain.....	2,778,200	2,880,000	3,303,900	3,000,700	3,056,600	2,526,500
Sweden.....	600			80,400	80,400	75,000
Yugoslavia.....	24,600	31,200	26,100	45,000	53,800	61,100
Asia:						
Burma.....	4,713,100	5,284,200	4,831,500	5,100,000	6,000,000	7,400,000
China.....	100,000	110,000	110,000	135,000	100,000	100,000
Chosen.....	39,300	54,700	70,200	51,900	51,400	51,400
East Indies, Netherlands.....	1,579,000	2,083,300	2,385,000	2,363,800	2,285,800	2,032,000
India, British.....	150,000	25,000	23,400	25,000	24,800	25,800
Indo-China.....					10,200	53,200
Japan.....	3,597,400	3,542,300	4,835,500	4,776,100	4,531,500	4,531,500
Taiwan.....	23,400	11,000	13,200	14,300	18,100	18,100
Turkey.....	8,000	219,900	219,900	225,000	225,100	220,000
Africa:						
Algeria.....			96,500	169,100	118,100	117,400
Bechuanaland.....			500	400	400	100
Belgian Congo.....	8,700				10,600	10,600
British West Africa (Gold Coast, Ashanti, Nigeria).....	70					100
East Africa, Portuguese.....			1,300	1,100	700	300
Rhodesia.....	161,500	401,300	158,000	117,800	131,600	103,900
Tanganyika.....		700	1,000	800	900	1,600
Transvaal, Cape Colony, Natal.....	1,373,900	1,396,900	1,161,500	981,300	1,011,700	1,031,400
Australasia:	13,818,700	10,769,900	10,841,000	11,225,400	10,309,300	10,308,900
	246,011,070	239,481,900	245,193,900	253,796,900	253,992,900	257,273,500

¹ Includes Philippine Islands as given on p. 873.

The exports of silver in 1928 were valued at about \$11,757,200 more than in 1927. Exports of domestic refined silver bullion amounted to 109,988,251 ounces, of which 66,843,486 ounces went to China and 33,615,082 ounces to British India. Germany and Great Britain took 5,128,419 ounces. Notwithstanding decreased sales to British India and the strife in China, the range in the price of silver was only a little over 3 cents an ounce in 1928. The long expected break in silver prices did not occur until the fourth quarter of 1929, when the price fell below 45 cents an ounce in New York. There were apparently no large purchasers of silver for coinage in 1928 nor much likelihood of much demand in the immediate future. The demand for silver for use in the arts and industries has been normal. There was an adverse court decision on the mandamus proceedings against the Treasury of the United States; the American Silver

Producers Association brought this action to compel the purchase of 14,587,730 ounces of silver for use in recoinage as provided under the terms of the Pittman Act.

MINE REPORT

METHOD OF COLLECTING STATISTICS

The first table in this report presents the final official figures of the production of gold and silver in the United States in 1928 as agreed upon by the Bureau of the Mint and the Bureau of Mines. With the comparatively unimportant exceptions of domestic gold and silver contained in ore and matte exported for reduction during the year, these figures record the production of gold and silver bullion from domestic ore in marketable form as metals, either refined or unrefined.

To trace this total gold and silver produced back to its source by States, counties, and mining districts, the Bureau of Mines makes a systematic investigation of the "mine production" of ores containing gold and silver and of the output of the placer mines, the output being classified by methods of production and by kinds of ore, as well as by mining districts. The resulting figures form the basis of the mine reports.

Of the two plans for ascertaining the gold and silver production, one is a measure of the metallurgic industry and the other a measure of the mining industry; one reports the metal actually recovered in marketable form and the other the mine output and its recoverable content. The two methods will not produce exactly corresponding results, but the figures for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error.

Gold and silver produced in the United States, 1905-1928, according to mint and to mine returns

Year	Mint		Mine	
	Gold	Silver	Gold	Silver
		<i>Fine ounces</i>		<i>Fine ounces</i>
1905-1918.....	\$1, 283, 273, 800	885, 783, 578	\$1, 273, 926, 803	889, 884, 359
1919.....	60, 333, 400	56, 682, 445	58, 225, 112	51, 907, 869
1920.....	51, 186, 900	55, 361, 573	50, 537, 281	56, 559, 022
1921.....	50, 067, 300	53, 052, 441	49, 788, 750	46, 359, 147
1922.....	48, 849, 100	56, 240, 048	48, 932, 109	61, 235, 983
1923.....	51, 734, 000	73, 335, 170	51, 400, 382	70, 393, 639
1924.....	52, 277, 000	65, 407, 186	52, 180, 812	64, 113, 882
1925.....	49, 860, 200	66, 155, 424	49, 645, 444	66, 776, 275
1926.....	48, 269, 600	62, 718, 746	48, 075, 596	62, 533, 373
1927.....	45, 418, 600	60, 434, 441	45, 242, 438	59, 656, 876
1928.....	46, 165, 400	58, 462, 507	46, 308, 487	57, 909, 870
	1, 787, 435, 300	1, 493, 633, 559	1, 774, 263, 214	1, 487, 330, 295

These figures show, according to the reports of the mint, a total excess of gold for the 24 years of \$13,172,086, or a difference of 0.74 per cent, and a total excess of silver of 6,303,264 ounces, or a difference of 0.42 per cent. The small differences are fully accounted for in the detailed discussions of the subject in previous reports of this series.

UNITS OF MEASUREMENT

In the measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price of gold is fixed by law at \$20.67+ per fine ounce. The annual average prices for silver from 1919 to 1928 are given on page 875.

MINES PRODUCING

LEADING GOLD PRODUCERS

About \$30,194,800 in gold, or 68 per cent of the mine output of the United States (Philippine Islands excluded) in 1928, was produced by 25 companies, none of which produced less than \$309,000. As in many former years, the Homestake mine in South Dakota was much the largest producer. The Alaska Juneau ranked second in total production of gold and the Yuba Consolidated Goldfields, the largest producer by dredging, dropped to fourth place. Eight of these large properties were in California, 4 in Arizona, 3 in Colorado, 3 in Alaska, 2 in Utah, 2 in Nevada, and 1 each in Montana, New Mexico, and South Dakota. Twelve of these properties produced gold from dry and siliceous ore; 4 from gravel by dredging; 3 from copper ore; 1 from siliceous ore, lead ore, and lead-zinc ore; 1 from copper ore and lead-zinc ore; 1 from copper ore and siliceous ore; 1 from copper ore and lead ore; 1 from copper ore, lead-zinc ore, and zinc ore; and 1 from lead-zinc ore.

Larger producers of gold in the United States in 1928, in order of output

Rank	Operator	State	Mining district	Source of gold
1	Homestake Mining Co.....	South Dakota.	Whitewood.....	Dry and siliceous ore.
2	Alaska Juneau Gold Mining Co..	Alaska.....	Juneau.....	Do.
3	Golden Cycle Mining & Reduction Co. ¹	Colorado.....	Cripple Creek.....	Do.
4	Yuba Consolidated Goldfields....	California.....	Marysville.....	Dredging gravel.
5	Utah Copper Co.....	Utah.....	West Mountain.....	Copper ore and lead-zinc ore.
6	Natomas Co. of California.....	California.....	Oroville and Folsom.	Dredging gravel.
7	Nevada Consolidated Copper Co..	Nevada.....	Robinson.....	Copper ore.
8	United Verde Copper Co.....	Arizona.....	Verde.....	Copper ore and siliceous ore.
9	Empire Mines & Investment Co..	California.....	Grass Valley.....	Dry and siliceous ore.
10	North Star Mines Co.....	do.....	do.....	Do.
11	Kennedy Mining & Milling Co.....	do.....	Jackson.....	Do.
12	Portland Gold Mining Co.....	Colorado.....	Cripple Creek.....	Do.
13	Phelps Dodge Corporation (Copper Queen).	Arizona.....	Warren.....	Copper ore and lead ore.
14	Original Sixteen to One Mines Co. (Inc.).	California.....	Alleghany.....	Dry and siliceous ore.
15	Argonaut Mining Co.....	do.....	Jackson.....	Do.
16	Fairbanks Exploration Co.....	Alaska.....	Fairbanks.....	Dredging gravel.
17	Hammon Consolidated Gold Fields.	do.....	Nome.....	Do.
18	Calumet & Arizona Mining Co..	Arizona.....	Warren.....	Copper ore.
19	Anaconda Copper Mining Co.....	Montana.....	Summit Valley (Butte).	Mainly copper ore, lead-zinc ore, and zinc ore.
20	Central Eureka Mining Co.....	California.....	Mother Lode.....	Dry and siliceous ore.
21	Smuggler Union Mining Co.....	Colorado.....	Upper San Miguel.	Do.
22	Park Utah Consolidated Mines Co.	Utah.....	Blue Ledge and Snake Creek.	Dry and siliceous ore, lead ore, and lead zinc ore.
23	Elkoro Mines Co.....	Nevada.....	Jarbridge.....	Dry and siliceous ore.
24	New Cornelia Copper Co.....	Arizona.....	Ajo.....	Copper ore.
25	American Metal Co.....	New Mexico..	Willow Creek.....	Lead-zinc ore.

¹ Custom mill. Includes ore from Cresson, United Gold, and other mines.

Besides the output of these large operators, \$14,209,625 in gold came from about 3,200 placer and lode mines, not including those in the Philippine Islands. A considerable number of these mines made substantial outputs, but most of them produced only small quantities of gold.

The Benguet Consolidated Mining Co., Philippine Islands, according to its printed report, produced nearly \$1,359,000 in gold in 1928. (See p. 910.) Only five companies in the United States exceeded this output.

LEADING SILVER PRODUCERS

The output of silver from the 25 leading producing properties in 1928 was about 36,916,000 ounces, or 64 per cent of the total. Thirteen of these properties each produced more than 1,000,000 ounces, and none of them yielded less than 600,000 ounces. The largest output of silver was that of the mines operated by the Anaconda Copper Mining Co., followed by that of the Tintic Standard Mining Co. and the Park Utah Consolidated Mines Co. The Presidio mine of the American Metal Co. in Texas increased its output considerably and was the largest producer of silver from ore that contained no appreciable quantity of any other metal. Nine of these large producers were in Utah, 4 in Arizona, 4 in Idaho, 3 in Montana, 2 each in Colorado and Nevada, and 1 in Texas. Three of these properties recovered silver from dry and siliceous ore; 3 from copper ore and lead-zinc ore; 3 from lead ore and lead-zinc ore; 3 from copper ore and lead ore; 3 from lead ore; 2 from dry and siliceous ore, lead ore, and lead-zinc ore; 2 from dry and siliceous ore and lead ore; 2 from copper ore, lead ore, and lead-zinc ore; 1 from copper-lead ore; 1 from copper ore; 1 from lead-zinc ore; and 1 from dry and siliceous ore and lead-zinc ore.

Larger producers of silver in the United States in 1928, in order of output

Rank	Operator	State	Mining district	Source of silver
1	Anaconda Copper Mining Co.....	Montana.....	Summit Valley (Butte).	Copper ore and lead-zinc ore.
2	Tintic Standard Mining Co.....	Utah.....	Tintic.....	Lead ore and siliceous ore.
3	Park Utah Consolidated Mines Co.	do.....	Blue Ledge and Snake Creek.	Dry and siliceous ore, lead ore, and lead-zinc ore.
4	Silver King Coalition Mines Co.	do.....	Uintah.....	Lead ore and lead-zinc ore.
5	United Verde Copper Co.....	Arizona.....	Verde.....	Copper ore and lead ore.
6	Bunker Hill & Sullivan Mining & Concentrating Co.	Idaho.....	Yreka.....	Lead ore.
7	Federal Mining & Smelting Co.	do.....	Hunter and Warm Springs.	Lead ore and lead-zinc ore.
8	Hecla Mining Co.....	do.....	Leland.....	Do.
9	Butte & Superior Mining Co.....	Montana.....	Summit Valley.....	Copper ore and lead-zinc ore.
10	American Metal Co.....	Texas.....	Shafer.....	Dry and siliceous ore.
11	Utah Copper Co.....	Utah.....	West Mountain.....	Copper ore, lead-zinc ore, and lead ore.
12	Sunshine Mining Co.....	Idaho.....	Evolution.....	Copper-lead ore.
13	Calumet & Arizona Mining Co.....	Arizona.....	Warren.....	Copper ore and lead ore.
14	Rawley Mines (Inc.).....	Colorado.....	Kerber Creek.....	Dry and siliceous ore.
15	Magma Copper Co.....	Arizona.....	Pioneer.....	Copper ore.
16	Bingham Mines Co.....	Utah.....	Tintic and West Mountain.	Dry and siliceous ore, lead ore, and lead-zinc ore.
17	Consolidated Cortez Mining Co....	Nevada.....	Cortez.....	Lead ore.
18	Ontario Silver Mining Co.....	Utah.....	Uintah.....	Dry and siliceous ore and lead-zinc ore.
19	North Lily Mining Co.....	do.....	Tintic.....	Lead ore.
20	Plutus Mining Co.....	do.....	do.....	Dry and siliceous ore and lead ore.
21	Sunnyside Mining & Milling Co....	Colorado.....	Eureka.....	Lead-zinc ore.
22	United States Smelting, Refining & Mining Co.	Utah.....	West Mountain.....	Lead ore, lead-zinc ore, and copper ore.
23	Tonopah Mining Co.....	Nevada.....	Tonopah.....	Dry and siliceous ore.
24	Elm Orlu Mining Co.....	Montana.....	Summit Valley.....	Copper ore and lead-zinc ore.
25	Phelps Dodge Corporation.....	Arizona.....	Warren.....	Copper ore and lead ore.

NUMBER OF MINES

The following table indicates the number of mines that produced gold and silver in 1928. The placers are those in which the gold and the silver that is in natural alloy with the gold and, in a few placers, with platinum also are recovered from gravel and sand, whether by hand washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or dredging. The lode mines are those producing gold and silver (from ore as distinguished from gravel) mainly from underground workings, including those whose ore is valuable chiefly for copper, lead, or zinc, but which contribute precious metals as by-products. In addition to producing mines here enumerated, many properties were being prospected and developed, and many other mining claims were being held by assessment work only.

The enumeration of placer mines is less satisfactory than that of lode mines, because some of the operations are only temporary and individually small and because much of the production is made by transitory miners not regularly working placer ground. The unit so far as possible is, as for lode mines, not the operator, but the mining claim or group of claims.

*Number of mines in the United States producing gold and silver in 1928, by States*¹

State	Placer	Lode	Total	State	Placer	Lode	Total
Alaska.....	460	26	486	North Carolina ²	1	4	5
Arizona.....	22	298	320	Oregon.....	90	41	131
California.....	460	287	747	Pennsylvania ²	1	1	1
Colorado.....	23	336	359	South Carolina.....	1	1	1
Georgia.....	2	1	3	South Dakota.....	4	5	9
Idaho.....	56	151	207	Tennessee ²	1	2	3
Illinois ²	3	3	3	Texas.....	7	7	7
Michigan ²	1	1	1	Utah.....	3	121	124
Missouri ²	2	2	2	Washington.....	1	37	38
Montana.....	43	236	279	Wyoming.....	3	3	3
Nevada.....	29	330	359				
New Mexico.....	6	93	99		1,202	1,985	3,187

¹ Philippine Islands excluded.

² Number of mines contributing to production of gold and silver.

Number of mines in the United States producing gold and silver, 1919-1928

Year	Placer	Lode	Total	Year	Placer	Lode	Total
1919.....	1,105	2,460	3,565	1925.....	1,236	2,445	3,681
1920.....	1,012	2,331	3,343	1926.....	1,276	2,399	3,675
1921.....	1,357	1,967	3,324	1927.....	1,280	2,048	3,328
1922.....	1,359	2,206	3,565	1928.....	1,202	1,985	3,187
1923.....	1,295	2,188	3,483				
1924.....	1,095	2,032	3,127	Average.....	1,222	2,206	3,428

The total number of properties operated in 1928 was 241 less than the average for the last 10 years. The number of placer properties worked showed a decrease of 78 compared with 1927 and was 1,114 less than the number operated in 1906. The number of lode mines operated was 63 less than in 1927 and 221 less than the average for the last 10 years.

Small increases in the number of lode mines operated were recorded in Arizona, Colorado, Idaho, North Carolina, Oregon, South Dakota, Texas, Washington, and Wyoming; the largest decreases were in California, Montana, Nevada, and New Mexico.

MINE PRODUCTION

SUMMARY

Mine production of gold and silver in the United States in 1928, by States

State	Gold		Silver		Increase or decrease from 1927	
	Fine ounces	Value	Fine ounces	Value	Gold	Silver (fine ounces)
Alaska.....	331, 126. 88	\$6, 845, 000	454, 700	\$266, 000	+\$918, 000	-173, 100
Arizona.....	191, 927. 23	3, 967, 488	6, 791, 351	3, 972, 940	-177, 103	-56, 329
California.....	521, 739. 59	10, 785, 315	1, 478, 771	865, 081	-885, 703	-141, 471
Colorado.....	256, 623. 38	5, 304, 876	4, 052, 253	2, 370, 568	+25, 758	+267, 648
Georgia.....	44. 07	911	5	3	-131	-23
Idaho.....	20, 080. 38	433, 703	8, 998, 330	5, 264, 023	+117, 100	+96, 921
Illinois.....			3, 146	1, 840		+1, 628
Michigan.....			17, 153	10, 035		-80, 040
Missouri.....			176, 840	103, 451		-57, 091
Montana.....	58, 196. 09	1, 203, 020	10, 853, 276	6, 349, 166	+96, 224	-346, 801
Nevada.....	175, 157. 79	3, 620, 833	5, 481, 574	3, 206, 721	+512, 902	+84, 395
New Mexico.....	32, 912. 41	680, 360	827, 793	484, 259	+75, 877	-62, 290
North Carolina.....	114. 46	2, 366	19, 051	11, 145	+1, 351	+19, 046
Oregon.....	10, 931. 19	225, 968	30, 924	18, 091	-77, 415	-14, 906
Pennsylvania.....	991. 98	20, 506	7, 905	4, 624	+14, 305	+5, 905
Philippine Islands.....	92, 109. 03	1, 904, 062	37, 427	21, 895	+217, 831	+6, 233
South Carolina.....	9. 53	197	1	1	+197	+1
South Dakota.....	317, 378. 94	6, 560, 805	90, 547	52, 970	-96, 182	-5, 624
Tennessee.....	537. 78	11, 117	75, 558	44, 201	+2, 301	-5, 902
Texas.....	489. 31	10, 115	1, 340, 622	784, 264	+1, 923	+305, 756
Utah.....	212, 559. 79	4, 394, 001	17, 072, 852	9, 987, 618	+385, 550	-1, 534, 098
Vermont.....						-821
Washington.....	16, 310. 45	337, 167	99, 738	58, 347	-66, 213	-56, 112
Wyoming.....	32. 75	677	53	31	-523	+48
	2, 240, 173. 03	46, 308, 487	57, 909, 870	33, 877, 274	+1, 066, 049	-1, 747, 006

The preceding table gives the quantity and value of the mine production of gold and silver in 1928, by States, as reported to the Bureau of Mines by the producing mines, and the increase or decrease by comparison with the corresponding figures for 1927.

The principal gold-producing States in 1928 were California, Alaska, South Dakota, Colorado, Utah, Arizona, and Nevada, and these States supplied 90 per cent of the total output. Alaska regained second place, and South Dakota fell to third. The only other change in order of output in the larger producing States was that Utah succeeded Arizona in fifth place. The notable increases in output in 1928 were in Alaska, Idaho, Montana, Nevada, New Mexico, Philippine Islands, and Utah. Small increases were recorded in Colorado, North Carolina, Pennsylvania, Tennessee, and Texas. The large decreases were in Arizona, California, Oregon, South Dakota, and Washington.

The principal silver-producing States in 1928 were Utah, Montana, Idaho, Arizona, Nevada, and Colorado, and these States produced about 92 per cent of the total; their ranking order was the same as for the three preceding years. There were large decreases in output of silver from Alaska, Arizona, California, Michigan, Missouri, Montana, New Mexico, Utah, and Washington. The only large increases were in Colorado, Idaho, Nevada, and Texas.

ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUE

The best index of lode mining is found in the quantity, metallic content, and value of ore mined, rather than in the number of mines or of operators. In the next table are given the production of ore from mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. The complex nature of western ores especially and the gradations from one well-recognized class to another render essential a fixed terminology. The dry and siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal-bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ore are both comparatively small. The copper ores include those containing 2.5 per cent or more of copper, or less than this percentage in the great disseminated copper deposits of the West and in the Lake Superior ores. In general, the lead ores are those containing 5 per cent (dry assay) or more of lead, and the zinc ores are those containing 16 per cent or more of zinc, both irrespective of their precious-metal content; but ores of lower grades in lead and especially in zinc are treated profitably in many districts, and, of course, they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of those enumerated.

The lead, zinc, and lead-zinc ores in most districts in the Eastern and Central States carry no appreciable quantity of gold or silver, and such ores are excluded from this report. With the increase in the use of flotation and the recovery of zinc concentrates from lead ore in southeastern Missouri there has been an increase in the total quantity of silver recovered in Missouri, as these zinc concentrates contain 18 to 20 ounces of silver a ton. Singularly, the lead concentrates from the lead ore treated in southeastern Missouri contain very little silver, approximately less than 5 per cent of that contained in the zinc concentrates. The proportion of silver derived from the total quantity of crude lead ore milled is very small.

The total quantity of ore sold or treated annually, from which gold or silver was produced, decreased from 68,000,000 tons in 1918 to 21,500,000 tons in 1921. It then increased steadily until 1926, when the total was 65,787,864 tons; in 1927 the total was 64,526,920 tons; and in 1928 the total quantity of ore was 69,747,193 tons, the largest output ever recorded.

Ore produced in the United States and average extraction value of gold and silver per ton in 1928, by States¹

State	Dry and siliceous ore		Copper ore		Lead ore		Zinc ore		Copper-lead and copper-lead-zinc ores		Lead-zinc ore		Total (short tons)
	Short tons	Average value	Short tons	Average value	Short tons	Average value	Short tons	Average value	Short tons	Average value	Short tons	Average value	
Alaska.....	3,736,500	\$0.95	579,500	\$0.35	—	—	—	—	22,083	\$5.17	—	—	4,316,000
Arizona.....	146,825	5.12	22,584,270	.65	50,651	\$4.43	—	—	137	21.08	24,937	\$2.86	22,828,766
California.....	797,441	7.74	901,562	.30	3,401	8.41	—	—	366	40.65	492,593	2.03	1,702,541
Colorado.....	894,455	7.02	11,983	12.83	26,687	6.04	—	—	—	—	—	—	1,426,064
Georgia.....	130	5.07	—	—	—	—	—	—	—	—	—	—	130
Idaho.....	10,571	23.51	31,454	5.26	1,136,581	2.38	450	\$0.69	49,322	13.60	825,951	2.10	2,054,329
Michigan.....	—	—	23,498	.43	—	—	—	—	—	—	—	—	23,498
Montana.....	112,331	5.18	3,174,509	1.27	10,419	11.16	89,405	.80	192,839	1.25	764,776	3.26	4,344,279
Nevada.....	641,004	5.95	6,244,047	.25	101,416	9.83	334	—	40,329	7.49	30,603	3.48	7,057,433
New Mexico.....	7,016	5.61	3,733,442	.12	13,211	2.53	371,072	—	—	—	249,233	2.55	4,073,974
North Carolina.....	70	6.71	73,330	.18	—	—	—	—	—	—	—	—	73,400
Oregon.....	8,084	13.96	4,577	1.65	15	180.87	—	—	—	—	—	—	12,676
Pennsylvania.....	—	—	1,083,140	2.68	—	—	—	—	—	—	—	—	1,083,140
South Dakota.....	1,422,138	4.65	—	—	95	9.54	—	—	—	—	—	—	1,422,233
Tennessee.....	—	—	739,995	.07	—	—	(²)	—	—	—	—	—	739,995
Texas.....	72,364	10.96	4,494	.28	57	6.02	—	—	—	—	—	—	76,915
Utah.....	211,758	9.01	16,631,757	.19	341,194	12.32	—	—	45,365	1.96	1,197,043	4.22	18,427,117
Washington.....	33,956	11.01	28,560	.55	887	3.63	330	—	706	.63	101	2.08	64,554
Wyoming.....	100	6.87	29	.72	—	—	—	—	—	—	—	—	129
Percentage.....	8,094,743	3.86	55,870,147	.31	1,086,614	5.09	161,311	.44	351,141	4.09	3,583,237	3.09	69,747,193
1927:	11.61	—	80.10	—	2.42	—	0.23	—	0.50	—	5.14	—	100.00
Total.....	8,549,720	3.59	49,966,438	.32	2,004,729	4.89	452,490	2.18	418,601	3.07	3,134,942	2.99	64,526,920
Percentage.....	13.25	—	77.43	—	3.11	—	0.70	—	0.65	—	4.86	—	100.00

¹ Illinois, Missouri, and Philippine Islands excluded; quantity of crude ore containing gold and silver not known.² Includes only copper ore that yielded silver.³ Zinc ore yielded no gold or silver.⁴ Ore is pyritiferous magnetite yielding 9.378 tons of low-grade copper concentrates; value given is per ton of concentrates.

Arizona led in total quantity of ore produced by more than 4,401,000 tons, with about 99 per cent of its output copper ore; Utah ranked second, with 90 per cent copper ore; Nevada was third, with 88 per cent copper ore; Montana was fourth, with 73 per cent copper ore; and Alaska, New Mexico, Idaho, California, Colorado, and South Dakota followed in order. The bulk of the ore from New Mexico was also copper ore, but the State yielded a large quantity of lead-zinc ore. The output from Idaho was largely lead ore and lead-zinc ore; that from Alaska and South Dakota was dry and siliceous ore; that from California was copper ore and dry and siliceous ore; and that from Colorado was dry and siliceous ore and lead-zinc ore.

The quantity of copper ore sold or treated in 1928 increased 5,903,709 tons, or 12 per cent, largely because of increased production in Arizona, California, Montana, Nevada, New Mexico, Tennessee, and Utah. The quantity of lead ore decreased in the Western States as a whole, although there were increases in Nevada, New Mexico, and Utah. The quantity of zinc ore decreased substantially, owing largely to lessened output in Montana. The quantity of lead-zinc ore increased 448,295 tons, or 14 per cent; the States showing the largest increases in output of lead-zinc ore were Arizona, Idaho, Montana, and New Mexico. The output of dry and siliceous ore decreased 454,977 tons; California, Nevada, and South Dakota showed increases in output, and Alaska, Arizona, Colorado, New Mexico, Oregon, Utah, and Washington showed decreases.

The value of the gold and silver recovered from 61,652,450 tons of base ores in 1928 was \$38,379,401, an average of 62 cents a ton, of which about 18 cents represents gold. The average recovery from dry and siliceous ore in 1928 was \$3.05 in gold a ton, so that a ton of such ore yielded 17 times as much gold as a ton of ore of all other classes combined and 20 times as much as was derived from a ton of copper ore which constituted more than 80 per cent of the total quantity of ores containing gold and silver in 1928. The large increase in the output of copper ore in 1928 affected only slightly the output of gold.

There may be some further increase in the quantity of gold from copper ore and also from lead-zinc ore, but no large increase in gold from base ores can be expected. Any such increase is likely to be balanced by decreased outputs from placer mines.

The total yield of gold from base ores in 1928 exceeded that in 1927 by about \$868,527; this increase was largely due to the higher yield from copper ore and copper-lead ore.

In 1928 the lead ore of Utah showed an average recovery in gold and silver of \$12.32 a ton and that of Idaho, which produced 67.5 per cent of the total output of lead ore containing gold, only \$2.38 a ton. Lead ore from Nevada (101,416 tons) yielded \$9.83 a ton. In the output of ore considered as producing gold and silver the proportion of dry and siliceous ore decreased from 13.25 to 11.61 per cent, that of lead ore from 3.11 per cent to 2.42 per cent, and that of copper ore increased from 77.43 per cent to 80.10 per cent. The proportion of all other classes of ore combined decreased from 6.21 per cent of the total in 1927 to 5.87 per cent in 1928. The figures show decreases in zinc ore and in copper-lead-zinc ore and a substantial increase in the quantity of lead-zinc ore.

During the period 1906 to 1928 the peak of production of dry and siliceous ore was reached in 1916, although the proportion of

such ores to the total was largest in 1906. The extraction value of these ores varies greatly, depending in a large degree on the quantity of low-grade ores milled in Alaska and South Dakota. In 1928 Alaska produced 46 per cent of the dry and siliceous ore treated, and Alaska and South Dakota together produced 64 per cent of the total. Most of this ore was milled at two properties.

The average recovery of gold and silver from dry and siliceous ore had steadily decreased from \$6.98 a ton in 1922 to \$3.59 in 1927. In 1928 the recovery increased to \$3.86 a ton, mainly as the result of the increase of 26 cents a ton in ore milled in Alaska. The decided decrease in the average extraction value of gold and silver in copper ore—from \$1.55 a ton in 1906 to 31 cents in 1928 (the lowest ever recorded)—was caused by the low gold and silver content of the much increased quantity of copper ore from Arizona, New Mexico, Nevada, and Utah. Silver predominates over gold in nearly all lead ore, the silver value being frequently 10 times that of the gold. As the price of silver fluctuates, the average extraction value shows a wider range than the quantity of ore. The recovery of gold and silver from lead ore in 1928—\$5.09 a ton—was slightly higher than in 1927, but lower than in any other year since 1915. Zinc ore constituted less than 0.3 per cent of the total ore shown in the table on page 886; its extraction value in gold and silver is very low. The lead-zinc ore yielded an average of only 45 cents a ton in gold but more than 4.5 ounces of silver a ton. The copper-lead and copper-lead-zinc ores have been mined in increasing quantity since 1921; the total produced in 1928 was a decrease of 16 per cent from 1927 but an increase of 24 per cent over the output in 1926. The ores usually contain good values in silver; those treated in 1928 averaged about 6.3 ounces of silver to a ton of crude ore. The gold recovered from such ores averaged about 41 cents a ton.

*Ore produced in the United States and average extraction value of gold and silver per ton, 1919–1928*¹

Year	Dry and siliceous ore		Copper ore		Lead ore	
	Short tons	Average value	Short tons	Average value	Short tons	Average value
1919.....	9,302,229	\$6.25	29,919,369	\$0.61	1,815,243	\$9.33
1920.....	8,590,139	6.26	32,447,410	.52	2,368,619	8.26
1921.....	8,436,214	6.65	10,930,888	.54	2,053,575	7.89
1922.....	8,728,222	6.98	23,356,128	.56	2,123,673	8.24
1923.....	9,121,719	5.91	41,596,309	.42	2,287,494	7.56
1924.....	8,979,113	5.21	44,887,379	.39	2,358,602	5.71
1925.....	8,994,910	4.57	47,186,114	.42	2,271,077	6.20
1926.....	8,743,386	4.03	51,064,058	.36	2,023,572	5.26
1927.....	8,549,720	3.59	49,966,438	.32	2,004,729	4.89
1928.....	8,094,743	3.86	55,870,147	.31	1,686,614	5.09

Year	Zinc ore		Copper-lead and copper-lead-zinc ores		Lead-zinc ore		Total (short tons)
	Short tons	Average value	Short tons	Average value	Short tons	Average value	
1919.....	88,654	\$0.52	17,632	\$15.97	1,365,945	\$4.91	42,509,072
1920.....	482,229	3.00	26,890	30.01	1,443,904	4.10	45,359,191
1921.....	10,116	.75	14,248	31.76	122,287	16.96	21,567,328
1922.....	471,172	3.68	52,370	13.76	444,845	7.89	35,176,410
1923.....	723,994	2.55	162,181	7.30	1,203,698	3.39	55,095,395
1924.....	145,858	.14	219,874	3.83	1,791,852	3.14	58,382,678
1925.....	169,432	.79	228,612	3.44	2,703,471	3.37	61,553,616
1926.....	214,366	1.03	282,015	3.38	3,460,467	3.01	65,787,864
1927.....	452,490	2.18	418,601	3.07	3,134,942	2.99	64,526,920
1928.....	161,311	.44	351,141	4.09	3,583,237	3.09	69,747,193

¹ Arkansas, Illinois, Missouri, Philippine Islands, and Porto Rico excluded; quantity of crude ore containing gold and silver not known.

GOLD, BY SOURCES

As shown in the following table, 75.08 per cent of the domestic output of gold in 1928 was obtained from dry and siliceous ores—normally gold quartz and gold-silver quartzose ores—and from placers, compared with 76.58 per cent in 1927. The total contribution of gold from the great copper, lead, and zinc mines of the country is relatively small, notwithstanding their enormous development and production of ore.

Mine production of gold in the United States in 1928, by States, in fine ounces ¹

State	Placers	Dry and siliceous ore	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
Alaska	161, 911. 13	169, 215. 75						331, 126. 88
Arizona	309. 60	22, 583. 49	161, 071. 48	3, 399. 64		3, 822. 74	740. 28	191, 927. 23
California	234, 649. 18	270, 081. 47	16, 677. 34	266. 95		64. 65		521, 739. 59
Colorado	2, 970. 51	238, 318. 68	769. 31	1, 181. 56		315. 29	13, 068. 03	256, 623. 38
Georgia	12. 34	31. 73						44. 07
Idaho	8, 191. 63	11, 195. 84	559. 38	487. 92	. 50	. 89	544. 22	20, 980. 38
Montana	865. 14	18, 492. 10	33, 546. 34	574. 72	130. 07	284. 61	4, 303. 11	58, 196. 09
Nevada	1, 851. 12	100, 303. 36	68, 530. 96	3, 143. 86		850. 85	477. 64	175, 157. 79
New Mexico	65. 16	1, 165. 44	16, 481. 69	155. 13			15, 044. 99	32, 912. 41
North Carolina	2. 95	22. 45	89. 06					114. 46
Oregon	5, 830. 40	4, 833. 75	248. 95	18. 09				10, 931. 19
Pennsylvania ²			991. 98					991. 98
South Carolina	9. 53							9. 53
South Dakota	11. 13	317, 365. 78		2. 03				317, 378. 94
Tennessee	14. 85		522. 93					537. 78
Texas		489. 31						489. 31
Utah	46. 00	25, 573. 78	115, 164. 28	26, 727. 17		1, 632. 79	43, 415. 77	212, 559. 79
Washington	90. 85	16, 098. 60	117. 00	2. 48		1. 00	. 52	16, 310. 45
Wyoming		32. 75						32. 75
Value	416, 831. 52	1, 195, 804. 28	414, 770. 70	35, 959. 55	130. 57	6, 972. 82	77, 594. 56	2, 148, 064. 00
Percentage	\$8, 616, 673	\$24, 719, 469	\$8, 574, 071	\$743, 350	\$2, 699	\$144, 141	\$1, 604, 022	\$44, 404, 425
	19. 41	55. 67	19. 31	1. 67	0. 01	0. 32	3. 61	100. 00
1927: Total	451, 214. 84	1, 162, 403. 43	367, 638. 75	41, 503. 78	1, 563. 22	2, 631. 29	80, 076. 21	2, 107, 031. 52
Value	\$9, 327, 439	\$24, 029, 012	\$7, 599, 768	\$857, 958	\$32, 314	\$54, 394	\$1, 655, 322	\$43, 556, 207
Percentage	21. 41	55. 17	17. 45	1. 97	0. 07	0. 13	3. 80	100. 00

¹ Philippine Islands excluded. The Bureau of Science, Manila, P. I., reports that bullion from lode mines of the Philippine Islands yielded 92,046 ounces of gold, and placer mines 63 ounces.

² From pyritiferous magnetite ore.

An examination of the domestic mine production of gold derived from different sources shows that the recovery of gold from placer mines was 27 per cent of the total output for the period 1906 to 1910, inclusive, and only 22.5 per cent of the total output for the period 1921 to 1925, inclusive. The recovery of gold from placer mines was only 21.4 per cent of the total in 1927 and 19.4 per cent in 1928. The recovery of gold from dry and siliceous ore was 67 per cent of the total output for the period 1911 to 1915, inclusive; it was only 55.2 per cent of the total in 1927 and 55.7 per cent in 1928. The domestic gold recovered from copper ore has increased from about 5.8 per cent of the total for the period 1906 to 1908, inclusive, to nearly 17.5 per cent in 1927 and to 19.3 per cent in 1928. The recovery of gold from all other base ores was about 2.3 per cent of the total for the period 1906 to 1910, inclusive, nearly 6 per cent in 1927, and 5.6 per cent in 1928. During the last 10 years copper ore and other base ores have yielded less than 15 per cent of the total output of gold and dry and siliceous ore and placers the remainder. It is evident that any large

increase in the gold output of the United States must come from the placers and from dry and siliceous ore. The gold from copper ore and other base ores may increase but this increase must be proportionately small. No new large bodies of dry and siliceous ore have been discovered, and the grade of the ore treated has decreased. Dredge mining is now the only large source of placer gold, and the area that can be mined by that process is declining in most of the western States. New dredges in Alaska will likely increase the production from that source, but it is questionable whether this increase will compensate for the smaller output of gold by dredges in California. It is probable that the gold production of the United States for the next few years will vary from \$45,000,000 to \$50,000,000, depending on the activity at base-metal mines, on lower costs at mines producing dry and siliceous ore, and on a larger output by dredges in Alaska.

*Gold produced in the United States, by sources, as reported by mines, 1919-1928, in fine ounces*¹

Year	Placers	Dry and siliceous ores	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
1919.....	704,377	1,780,567	186,701	41,945	86	1,043	38,563	2,753,282
1920.....	603,002	1,523,331	171,055	46,776	3,657	3,731	31,435	2,382,987
1921.....	677,435	1,548,251	52,765	61,924	76	159	4,400	2,345,010
1922.....	537,910	1,560,789	130,928	35,415	2,807	2,467	22,935	2,293,251
1923.....	551,929	1,510,098	271,690	38,109	3,321	3,801	25,965	2,404,913
1924.....	450,720	1,602,469	310,413	39,947	227	1,995	38,560	2,444,331
1925.....	436,251	1,414,446	348,025	50,378	375	5,515	52,384	2,307,374
1926.....	457,717	1,295,570	365,223	45,724	1,194	3,335	63,763	2,232,526
1927.....	451,215	1,162,404	367,639	41,504	1,563	2,631	80,076	2,107,032
1928.....	416,832	1,195,804	414,771	35,959	130	6,973	77,595	2,148,064

¹ Philippine Islands and Porto Rico excluded.

PLACERS

General features.—The output of gold from placer mines in the United States (Philippine Islands excluded) in 1928 was 416,832 ounces, compared with 451,215 ounces in 1927. The States showing the largest decreases were California (47,731 ounces), Colorado (1,598 ounces), Montana (215 ounces), New Mexico (216 ounces), and Oregon (3,056 ounces). Alaska showed the only increase of note (17,657 ounces), although the placer mines in Arizona, Idaho, Nevada, South Carolina, Tennessee, Utah, and Washington yielded more in 1928 than in 1927. The placer gold is derived chiefly from dredging (which yielded 80 per cent of the total in 1928), from placers operated by hydraulicking, and from those worked by drift mining or by sluicing. The last two methods are now relatively unimportant except in Alaska and California. There is also a small annual output of gold from dry placer mining in Arizona, California, and New Mexico and of gold and platinum from ocean-beach mining in California and Oregon, but these sources are also insignificant as producers of gold.

Dredging.—The value of gold recovered by dredges in the United States from the commercial inception of the industry in 1896 to the end of 1928 has amounted, according to the most authentic data available, to \$225,527,208, of which \$159,964,684 came from Cali-

ifornia, \$36,075,474 from Alaska, \$9,592,435 from Montana, \$8,101,924 from Colorado, \$6,026,932 from Idaho, \$5,136,747 from Oregon, and \$629,012 from other States.

The output of gold from dredges in 1928 was \$6,892,331, compared with \$7,515,590 in 1927; the number of dredges operated in 1928 was 57, compared with 59 in 1927. Of the total for 1928 California produced \$4,430,913 from 24 dredges, Alaska \$2,185,000 from 26 dredges, Idaho \$133,418 from 3 dredges, Oregon \$90,103 from 2 dredges, Colorado \$51,019 from 1 dredge, and Washington \$1,878 from 1 dredge. In addition, a dredge operated in the Philippine Islands in 1928 produced about \$1,300 in gold.

Gold produced in the United States by dredges, 1919-1928

Year	Dredges	California	Alaska	Other States ¹	Total
1919	91	\$7,716,919	\$1,360,000	\$1,269,297	\$10,346,216
1920	78	6,900,366	1,129,932	1,256,153	9,286,456
1921	72	7,756,787	1,582,520	1,196,261	10,535,568
1922	71	4,999,215	1,767,753	922,300	7,689,268
1923	66	6,065,735	1,848,596	1,084,716	8,999,047
1924	63	4,305,521	1,563,361	1,044,099	6,912,981
1925	60	4,750,842	1,572,312	507,874	6,831,028
1926	63	4,950,545	2,291,000	281,240	7,522,785
1927	59	5,461,929	1,740,000	313,661	7,515,590
1928	57	4,430,913	2,185,000	276,418	6,892,331

¹ Colorado, Idaho, Montana, Nevada, Oregon, and Washington.

Further information on this subject may be found in previous issues of Mineral Resources, in reports of the Director of the Mint, and in reports of geological surveys or mining officials of the various States.

DRY AND SILICEOUS ORES

The siliceous ore comprises free-milling (amalgamating) ore, as in Alaska, California, and Oregon; both amalgamating and concentrating ore, as in many States; simply concentrating ore, as in parts of Colorado and Arizona; all-sliming and cyaniding ore, as in Nevada; and finally smelting ore. Tailings both from old dumps and from current millings are largely reworked by concentration and subsequent cyanidation or smelting. The material smelted consists mainly of concentrates and of siliceous and pyritic ores, which are also valuable as fluxes. Figures of relative output by methods and by States are given on page 897.

As most of the gold produced in the United States is derived from placer gravel and dry and siliceous ores, including true gold, gold-silver, and silver ores, the following table for certain States is of special interest.

Nearly all the siliceous ore in three of the largest gold-producing States—Alaska, California, and South Dakota—yields only a small quantity of silver and is classed as gold ore. The siliceous ore from Colorado includes much silver and gold-silver ore.

Siliceous ore treated and gold recovered per ton of ore treated, 1919–1928

Year	Alaska		California		South Dakota		Colorado	
	Ore treated	Recovery per ton	Ore treated	Recovery per ton	Ore treated	Recovery per ton	Ore treated	Recovery per ton
	<i>Short tons</i>	<i>Ounce</i>	<i>Short tons</i>	<i>Ounce</i>	<i>Short tons</i>	<i>Ounce</i>	<i>Short tons</i>	<i>Ounce</i>
1919.....	3,262,573	0.068	1,212,142	0.339	1,330,349	0.177	1,667,076	0.258
1920.....	3,413,736	.063	788,136	.439	1,356,098	.167	1,224,081	.257
1921.....	2,894,813	.064	902,566	.402	1,725,669	.185	1,230,172	.250
1922.....	2,513,455	.058	1,052,148	.414	1,751,454	.180	1,296,501	.221
1923.....	2,502,901	.045	925,659	.347	1,665,439	.186	1,166,470	.243
1924.....	3,127,876	.042	1,075,858	.364	1,674,720	.177	1,074,876	.344
1925.....	3,573,540	.042	886,625	.413	1,590,079	.182	1,187,054	.271
1926.....	3,924,925	.036	717,326	.433	1,415,785	.197	1,240,195	.259
1927.....	4,352,000	.033	619,122	.428	1,376,583	.234	1,035,305	.227
1928.....	3,736,500	.045	797,441	.339	1,422,138	.223	894,455	.266

The quantity of siliceous ore treated in South Dakota in 1928 was 45,555 tons more than that in 1927, but the recovery of gold per ton was 23 cents less; the quantity of siliceous ore from California was 178,319 tons more, and the recovery of gold per ton was \$1.84 less; the quantity of siliceous ore treated in Alaska was 615,500 tons less, and the recovery of gold per ton was 26 cents more; and the quantity of siliceous ore treated in Colorado was 140,850 tons less, and the recovery of gold per ton was 82 cents more. These four States yielded 84.6 per cent of the total dry and siliceous ore treated in 1928 and 83.2 per cent of the total gold from such ores.

COPPER ORE

The gold obtained as a by-product in the treatment of copper ore showed an increase in 1928 of about \$974,300, following increases of about \$355,500 in 1926 and \$50,000 in 1927. Copper ore yielded a larger percentage of the total gold in 1928 than in 1927. The largest producer of gold from copper ore in 1928 was Arizona, with about 39 per cent of the total; Utah, with nearly 28 per cent, ranked second, and was followed by Nevada, Montana, California, and New Mexico. The largest gains in gold derived from copper ore were in Nevada (21,647 ounces), Utah (15,107 ounces), Montana (6,305 ounces), New Mexico (2,039 ounces), and Arizona (1,228 ounces).

LEAD ORE

The production of gold from lead ore showed a decrease of 13 per cent compared with the output in 1927. Nearly all the States showed decreased yields from lead ore; Utah showed an increase of 6,858 ounces and produced 74 per cent of all the gold recovered from lead ore.

ZINC, LEAD-ZINC, AND MIXED ORES

The output of gold from zinc ore was comparatively small in 1928, being 1,433 ounces less than in 1927; nearly all of it came from Montana. The output of gold from lead-zinc ore decreased 2,482

ounces in 1928; it came largely from Utah, New Mexico, Colorado, and Montana. The output of gold from copper-lead and copper-lead-zinc ores increased 4,342 ounces; 78 per cent of it came from Arizona and Utah.

SILVER, BY SOURCES

The mine production of silver in 1928 from the chief sources—lead-zinc ore, copper ore, lead ore, and siliceous ore—was 96 per cent of the total, compared with 93 per cent of the total from the same classes of ore in 1927. The combined yield of silver from placer bullion, zinc ore, and mixed ores was 4 per cent of the total, compared with 7 per cent in 1927. The production of silver in 1928, as reported by the mines, was 57,872,443 fine ounces—the smallest output since 1921 and less than three-fourths of that in the record year 1916. The combined output from lead and lead-zinc ores increased from 29,386,341 ounces in 1927 to 29,627,087 ounces in 1928. The recovery from siliceous ore decreased 634,888 ounces and was the smallest annual recovery in more than a score of years, being 61 per cent less than that in the record year 1922. The recovery from copper ore increased 177,280 ounces over that in 1927. The total recovery of silver from base ores was about 1,115,000 ounces less in 1928 than in 1927.

Mine production of silver in the United States in 1928, by States, in fine ounces¹

State	Placers	Dry and siliceous ore	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
Alaska.....	23,930	80,340	350,430	-----	-----	-----	-----	454,700
Arizona.....	46	486,842	5,885,625	263,130	-----	60,162	95,546	6,791,351
California.....	17,211	1,006,138	413,326	39,443	-----	2,653	-----	1,478,771
Colorado.....	728	2,318,331	235,581	233,611	-----	14,292	1,249,710	4,052,253
Georgia.....	-----	5	-----	-----	-----	-----	-----	5
Idaho.....	2,538	29,203	262,938	4,623,567	517	1,146,417	2,933,150	8,998,330
Illinois.....	-----	-----	-----	3,146	-----	-----	-----	3,146
Michigan.....	-----	-----	17,153	-----	-----	-----	-----	17,153
Missouri.....	-----	-----	-----	176,840	-----	-----	-----	176,840
Montana.....	149	340,876	5,705,513	178,520	117,015	402,705	4,108,498	10,853,276
Nevada.....	839	2,977,433	258,519	1,593,463	-----	485,946	165,374	5,481,574
New Mexico.....	17	26,104	197,389	51,584	-----	-----	552,699	827,793
North Carolina.....	-----	11	19,040	-----	-----	-----	-----	19,051
Oregon.....	779	22,042	4,104	3,999	-----	-----	-----	30,924
Pennsylvania.....	-----	-----	7,905	-----	-----	-----	-----	7,905
South Carolina.....	1	-----	-----	-----	-----	-----	-----	1
South Dakota.....	-----	89,070	-----	1,477	-----	-----	-----	90,547
Tennessee.....	2	-----	75,556	-----	-----	-----	-----	75,558
Texas.....	-----	1,337,918	2,118	586	-----	-----	-----	1,340,622
Utah.....	6	2,355,975	1,275,682	6,241,616	-----	94,304	7,105,269	17,072,852
Washington.....	30	70,191	22,937	5,414	-----	721	445	99,738
Wyoming.....	-----	17	36	-----	-----	-----	-----	53
Value.....	46,276	11,140,496	14,733,852	13,416,396	117,532	2,207,200	16,210,691	57,872,443
Percentage.....	\$27,071	\$6,517,190	\$8,619,304	\$7,848,592	\$68,756	\$1,291,212	\$9,483,254	\$33,855,379
	0.08	19.25	25.46	23.18	0.20	3.82	28.01	100.00
1927: Total.....	49,829	11,775,384	14,556,572	15,762,197	1,685,764	2,171,792	13,624,144	59,625,682
Value.....	\$28,253	\$6,676,643	\$8,253,576	\$8,937,166	\$955,828	\$1,231,406	\$7,724,890	\$33,807,762
Percentage.....	0.08	19.75	24.41	26.44	2.83	3.64	22.85	100.00

¹ Philippine Islands excluded. The Bureau of Science, Manila, P. I., reports that bullion from lode mines of the Philippine Islands yielded 37,409 ounces of silver, and placer bullion yielded 18 ounces.

² From fluor spar-lead ores.

³ From pyritiferous magnetite ore.

*Silver produced in the United States, by sources, as reported by mines, 1919-1928, in fine ounces*¹

Year	Placers	Dry and siliceous ore	Copper ore	Lead ore	Zinc ore	Copper-lead and copper-lead-zinc ores	Lead-zinc ore	Total
1919.....	78,401	19,043,515	12,880,624	14,351,293	39,480	232,157	5,273,990	51,899,460
1920.....	73,383	20,477,612	12,151,424	17,069,506	1,258,341	669,503	4,837,135	56,536,904
1921.....	81,375	24,117,251	4,782,538	14,912,990	6,163	449,417	1,983,222	46,332,956
1922.....	60,769	28,631,579	10,376,123	16,756,835	1,676,967	669,809	3,035,907	61,207,989
1923.....	57,752	27,636,947	14,684,333	20,139,928	2,171,186	1,348,025	4,317,503	70,355,674
1924.....	51,251	20,388,065	16,335,433	18,858,782	24,431	1,194,323	7,218,459	64,070,744
1925.....	50,303	17,099,876	18,051,937	18,777,853	181,886	970,370	11,577,855	66,710,080
1926.....	49,890	13,567,095	17,039,546	15,528,454	313,119	1,415,699	14,573,416	62,487,219
1927.....	49,829	11,775,384	14,556,572	15,762,197	1,685,764	2,171,792	13,624,144	59,625,682
1928.....	46,276	11,140,496	14,733,852	13,416,396	117,532	2,207,200	16,210,691	57,872,443

¹ Philippine Islands and Porto Rico excluded.

PLACERS

The recovery of silver from the refining of placer gold in 1928 was 3,553 ounces less than that in 1927. Of the total production 89 per cent came from Alaska and California. The bullion from placers in Nevada contained the largest percentage of silver followed by that from placers in Idaho. High-grade placer bullion was also produced at Arizona and Oregon mines. The bullion from placers in California contained the smallest percentage of silver.

DRY AND SILICEOUS ORES

About 27 per cent of the mine production of silver from dry and siliceous ore came from Nevada, 21 per cent from Utah (mainly from the Tintic district), and 21 per cent from Colorado. The only large increases in the quantity of silver from siliceous ore were in Arizona and Texas, and the large decreases were in California, Colorado, Montana, Nevada, New Mexico, Oregon, Utah, and Washington.

A large part of the silver from gold-silver siliceous ore is obtained with the gold by amalgamation and cyanidation in the mills. Very little of the gold and silver ores is treated by flotation, which is so extensively used on base ores, and no estimate is available for the quantity so treated in 1928. The remainder of the silver is recovered by smelting the richer ore and refining the base bullion.

The Engineering and Mining Journal of November 16, 1929, contains an abstract of an article, prepared by Dr. Eng. Quittkat, entitled "Flotation of gold ore in continental Europe." The writer states that "flotation as a gold concentration method will probably be limited to small ore occurrences for which the investment in a cyanide plant is not justified. In most instances, however, flotation in combination with amalgamation and cyanidation will be employed as a preliminary treatment of the ore for the purpose of removing objectionable mineral constituents. This procedure will decrease cyaniding costs and make possible a higher recovery of gold and silver."

COPPER ORE

The silver produced from copper ore is nearly all obtained in the electrolytic refining of Lake and blister copper. The copper ore is mainly sulphide (except the Lake ore of Michigan, which consists of

native metal in amygdaloid and conglomerate matrix), and a greater quantity contains chalcocite than chalcopyrite or cupriferous pyrite. The silver tenor of much of the copper ore, especially that of the Santa Rita district, New Mexico, of Bingham, Utah, and of Ely, Nev., is notably low, but other regions yield copper ore that contains considerable quantities of silver.

In output of silver from copper ore Arizona took first place from Montana with a yield of 5,885,625 ounces in 1928, compared with 5,702,270 ounces in 1927. Montana was second with 5,705,513 ounces, compared with 6,201,827 ounces in 1927. Utah was again third with 1,275,682 ounces, compared with 1,138,014 ounces in 1927. These three States yielded 87 per cent of the total silver recovered from copper ore in 1928. The production of Arizona comes mainly from Bisbee and Jerome, that of Montana mainly from Butte, that of Utah mainly from Bingham, and that of California mainly from Plumas County. Of these districts Bisbee well represents the disseminated type, Bingham produces from both lode and disseminated deposits, and the remainder produce silver chiefly from copper ore mined from deep lodes. Some silver is also produced in leaching copper ore.

LEAD ORE

The mine production of silver from argentiferous lead ore was about 2,345,800 ounces less in 1928 than in 1927. The only large increase was in Nevada (188,045 ounces). The largest decreases were in Arizona (346,600 ounces), California (33,200 ounces), Idaho (986,000 ounces), Missouri (57,100 ounces), Montana (135,600 ounces), and Utah (972,600 ounces). Most of the output is obtained from the desilverization of lead bullion from the smelting of western concentrates. The largest producers of silver-lead ore are the mines in the Park City and Tintic districts in Utah and in the Coeur d'Alene region in Idaho; several hundred mines in many other districts contribute varying quantities of silver from silver-lead ore.

ZINC, LEAD-ZINC, AND MIXED ORES

The mine production of silver from argentiferous zinc ore decreased from 1,685,764 ounces in 1927 to 117,532 ounces in 1928. This decrease was due mainly to decreased output credited to zinc ore from Montana mines and is partly accounted for by recoveries credited to lead-zinc ore from that State. The lead-zinc mines in California were mostly idle; no silver was reported from them in 1928. The output of silver from lead-zinc ore increased from 13,624,144 ounces in 1927 to 16,210,691 ounces in 1928. The largest producer of silver from lead-zinc ore was Utah with 7,105,269 ounces; other large contributors were Montana with 4,108,498 ounces, Idaho with 2,933,150 ounces, Colorado with 1,249,710 ounces, and New Mexico with 552,699 ounces. Silver from copper-lead and copper-lead-zinc ores increased from 2,171,792 ounces in 1927 to 2,207,200 ounces in 1928. More than half the output in 1928 was from Idaho. Other large producers of silver from these classes of ore were mines in Nevada, Montana, Utah, and Arizona.

GOLD AND SILVER, BY METHODS OF TREATMENT

The following table gives the production of gold and silver from ore, old tailings, etc., treated in 1927 and 1928.

Gold and silver produced in the United States from ore, old tailings, etc., in 1928, by States and by methods of recovery ¹

State	Total quantity of crude ore, old tailings, etc., treated (short tons)	Ore, old tailings, etc., to gold and silver mills				Ore and old tailings to concentrating mills (short tons)	Concentrates from all sources			Crude ore to smelters			Ore leached, old tailings and slag smelted, etc.			
		Ore (short tons)	Old tailings, etc. (short tons)	Gold in bullion (fine ounces)	Silver in bullion (fine ounces)		Short tons	Gold (fine ounces)	Silver (fine ounces)	Short tons	Gold (fine ounces)	Silver (fine ounces)	Short tons	Gold (fine ounces)	Silver (fine ounces)	
Alaska.....	4,316,000	3,733,417	-----	2,130,710	2,20,589	568,362	65,385	36,497	294,642	14,221	2,009	115,539	-----	-----	-----	-----
Arizona.....	22,828,766	31,290	1,100	14,423	20,379	15,885,447	900,172	50,130	1,886,318	2,792,369	126,972	4,871,856	-----	-----	-----	12,752
California.....	1,702,541	612,665	116,667	226,925	338,294	732,991	55,462	56,036	948,905	175,847	3,943	172,699	4,371	186	-----	1,662
Colorado.....	1,426,034	630,718	(⁶)	184,373	211,670	712,490	158,736	49,062	3,060,601	82,876	20,218	779,254	-----	-----	-----	-----
Idaho.....	2,054,329	10,003	51	8,461	3,483	1,999,511	314,994	2,206	8,010,023	44,763	2,120	982,286	1	-----	-----	-----
Montana.....	4,344,279	62,666	1,977	11,196	15,165	4,090,213	699,796	39,665	10,295,838	94,383	6,023	485,863	95,040	447	56,261	-----
Nevada.....	7,057,433	305,718	245,430	81,067	2,729,471	6,272,318	376,631	69,737	1,913,778	233,371	22,399	827,744	596	104	9,742	-----
New Mexico.....	4,073,974	3,000	-----	873	140	3,922,191	225,096	20,519	625,670	148,783	11,455	201,966	-----	-----	-----	-----
Oregon.....	12,676	3,369	-----	2,767	728	7,500	549	1,776	21,994	1,807	558	7,423	-----	-----	-----	-----
South Dakota.....	1,422,233	1,422,138	(⁶)	317,366	89,070	-----	-----	-----	-----	95	2	1,477	-----	-----	-----	-----
Texas.....	76,915	57,475	-----	381	970,115	-----	1,025	108	242,225	19,440	53	128,282	-----	-----	-----	-----
Utah.....	18,427,117	5	-----	10	3	17,861,682	793,009	155,507	9,045,020	511,606	53,035	7,768,566	53,824	3,962	259,257	-----
Washington.....	64,554	4,751	130	3,538	203	-----	1,886	106	11,067	30,355	12,576	88,438	-----	-----	-----	-----
Wyoming.....	129	100	-----	33	17	-----	-----	-----	-----	29	-----	36	-----	-----	-----	-----
Eastern States.....	71,916,665	200	-----	54	16	\$1,459,784	\$51,408	1,258	45,805	\$456,681	346	56,696	-----	-----	-----	-----
Total, 1927.....	69,723,695	6,877,515	365,355	982,177	4,399,343	53,601,807	3,644,149	482,607	36,401,886	4,606,636	261,656	16,488,125	4,272,392	4,792	339,674	-----
	64,433,974	7,596,254	145,308	987,984	4,323,349	48,055,809	3,913,758	414,000	35,208,421	4,238,737	243,053	19,069,490	4,397,866	10,779	641,951	-----

¹ Exclusive of gold or silver, as follows: From copper ore in Michigan, from lead ore in Missouri, from fluorspar ore in Illinois, and from siliceous ore in Philippine Islands.² Exclusive of bullion from 2,191 tons of concentrates amalgamated or cyanided, figures for which are included under "Concentrates from all sources."³ Also 7,061 tons of concentrates from California were cyanided and yielded 31,448.45 ounces of gold and 9,655 ounces of silver. The figures are included under "Concentrates from all sources."⁴ Includes 10,104.58 ounces of gold and 2,111 ounces of silver from "high grade."⁵ Sands and slimes (313,127 tons) from ore and concentrates first treated by amalgamation were cyanided.⁶ Sands and slimes (1,371,096 tons) from ore and concentrates first treated by amalgamation were cyanided.⁷ Includes low-grade pyritic magnetite ore from Pennsylvania; excludes ore containing no gold and silver⁸ Includes only ore or concentrates that yielded gold and silver.

The greatest output of ore, etc., was made in Arizona, Utah, Nevada, Montana, and New Mexico, all notable for large yields of copper ore; in Idaho, a large producer of lead ore and lead-zinc ore; in Alaska and California, large producers of both copper and siliceous ores; and in South Dakota and Colorado, large producers of siliceous ore.

The only large increases in ore sent direct to gold and silver mills were in California, Idaho, Montana, South Dakota, and Texas. Many gold and silver mills employ concentrating apparatus, and the concentrates they obtain are combined in the preceding table with those from straight concentrating mills under the heading "Concentrates from all sources." The gold and silver included in this item are recovered partly by amalgamation (particularly in Alaska and California) and cyanidation, although most of the concentrates are smelted.

The figures for the quantity of ore treated by concentration include the large quantities of copper, lead, zinc, and mixed ores whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper and lead bullion and smelting the zinc residues. The quantity of concentrates produced and the recoverable gold and silver content represent not only the concentrates from these straight concentrating mills but also the comparatively small quantity from gold and silver mills.

Of the total quantity (53,601,807 tons) of ore sent direct to concentrating plants in the United States in 1928, Utah contributed 17,861,682 tons and Arizona 15,885,447 tons—a total of nearly two-thirds of all ore so treated. The large output from these two States was mainly due to the large quantities of copper ore directly concentrated. Of the total gold recovered from concentrates 68 per cent came from four States, as follows: Utah, 32 per cent; Nevada, 14 per cent; California, 12 per cent; and Arizona, 10 per cent. Of the silver from concentrates 22 per cent came from Idaho, 28 per cent from Montana, and 25 per cent from Utah; large quantities also came from Arizona, California, Colorado, Nevada, and New Mexico. The increase of 12 per cent in 1928 in the quantity of ore directly concentrated was due to the large quantities milled in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, and Utah.

No figures are available showing the quantity of gold and gold-silver ores treated by flotation in 1928, but the quantity was very small compared with the immense tonnages of base ores so treated.

The figures for the quantity and the recoverable precious-metal content of crude ore shipped from the mines direct to the smelters include, in general, the richer gold, silver, copper, lead, and mixed ores from which the gold and silver are eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. There has been a large decrease in the last decade in the quantity of crude ore directly smelted and a large increase in the quantity of ore concentrated. In 1928 Arizona produced 61 per cent of the ore directly smelted, and Utah and Arizona produced 77 per cent of the silver and 69 per cent of the gold recovered from crude ore smelted.

The old materials, mainly tailings and slags, re-treated (with which are included figures for ore and old tailings leached) are partly smelted,

often for their fluxing as well as their metal value; considerable quantities of old tailings were concentrated and cyanided in 1928, and the impounding of mill tailings for future treatment, as well as because of legal requirements, has become a general practice. Most of the gold and silver derived from old tailings is included under recoveries by amalgamation and cyanidation at gold and silver mills.

Of the crude ore shipped direct to smelters (4,606,626 tons) in 1928 Arizona contributed 2,792,369 tons, mainly copper ore, yielding 49 per cent of the gold and 30 per cent of the silver recovered from ore directly smelted. Mines in Utah shipped to smelters 511,606 tons of crude ore, yielding 20 per cent of the gold and 47 per cent of the silver recovered by smelting crude ores.

*Gold and silver produced at mills in the United States and percentage of gold and silver recovered by smelting and from placers, 1919-1928*¹

Year	Ore, old tailings, etc., treated (short tons)	Bullion recovered from all sources (fine ounces)			
		Amalgamation		Cyanidation	
		Gold	Silver	Gold	Silver
1919.....	8,668,507	839,761	279,793	685,330	7,163,726
1920.....	7,560,043	679,409	228,807	580,205	7,582,358
1921.....	7,429,125	765,397	207,877	559,352	7,414,275
1922.....	7,442,998	812,396	183,119	541,318	8,803,787
1923.....	7,657,613	683,274	179,527	607,415	10,044,388
1924.....	8,023,899	746,777	231,742	563,208	8,921,688
1925.....	8,022,807	753,313	214,790	476,599	6,360,571
1926.....	7,948,788	682,345	184,640	455,640	5,173,664
1927.....	7,741,562	649,044	195,895	377,833	4,177,848
1928.....	7,242,870	684,744	226,352	365,379	4,242,270

Year	Percentage of gold and silver from all sources							
	Amalgamation		Cyanidation		Placers		Smelting ²	
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
1919.....	31.5	0.5	28.5	13.8	25.6	0.15	14.4	85.5
1920.....	28.5	.4	24.3	13.4	25.3	.13	21.9	86.1
1921.....	32.6	.45	23.9	16.0	28.9	.18	14.6	83.4
1922.....	35.4	.3	23.6	14.4	23.5	.1	17.5	85.2
1923.....	28.4	.3	25.3	14.3	22.9	.1	23.4	85.3
1924.....	30.6	.4	23.0	13.9	18.4	.1	28.0	85.6
1925.....	32.6	.3	20.7	9.5	18.9	.1	27.8	90.1
1926.....	30.6	.3	20.4	8.3	20.5	.1	28.5	91.3
1927.....	30.8	.3	17.9	7.0	21.4	.1	29.9	92.6
1928.....	31.9	.4	17.0	7.3	19.4	.1	31.7	92.2

¹ Philippine Islands and Porto Rico excluded.

² Both crude ores and concentrates.

About 19 per cent of the total gold output in 1928 came from placers; the percentage of the output of silver credited to the placers was insignificant. Colorado, Nevada, and South Dakota yielded the larger part of the gold recovered by cyanidation; the decrease in the quantity of gold recovered by cyanidation was due mainly to the large declines in Arizona, California, and South Dakota. Nevada was the only State to show an appreciable increase in gold recovered

by amalgamation and by cyanidation. The largest decreases in gold recovered by amalgamation were in Colorado and Washington; increases were shown in Alaska, California, Idaho, Montana, Nevada, Oregon, and South Dakota. The only States to show an increased yield of gold by cyanidation in 1928 were Colorado, Montana, Nevada, and Texas. The quantity of gold recovered by cyanidation decreased markedly, whereas that recovered from ores and concentrates smelted increased. The quantity of silver recovered by cyanidation in 1928 increased about 64,400 ounces, and that recovered by smelting decreased about 2,581,400 ounces.

A large quantity of concentrates from sulphide ores is now smelted, and the increased application of the flotation process to base ores has resulted in more concentrates being shipped to smelters. The smelters are credited in 1928 with 31.7 per cent of the total output of gold and 92.2 per cent of the silver, compared with 14.4 per cent of the gold and 85.5 per cent of the silver in 1919.

The bulk of the gold produced continues to come from the gold mills, although the proportion of gold so recovered in 1928 was only 48.9 per cent of the total, compared with 60 per cent in 1919.

Gold and silver bullion produced at mills in 1928, by States ¹

State	Ore, old tailings, etc., treated (short tons)	Bullion recovered from all sources (fine ounces)				Percentage of gold and silver from all sources in State			
		Amalgamation		Cyanidation		Amalgamation		Cyanidation	
		Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
Alaska.....	² 3, 733, 417	166, 067	80, 113	1, 140	100	50.2	17.6	0.3	-----
Arizona.....	32, 390	533	276	13, 890	20, 103	.3	-----	7.2	0.3
California.....	² 729, 332	221, 000	63, 621	37, 374	284, 328	42.4	4.3	7.2	19.2
Colorado.....	³ 630, 718	56, 781	14, 964	127, 592	196, 706	22.1	.4	49.7	4.9
Idaho.....	10, 054	8, 459	3, 277	2	206	40.3	-----	-----	-----
Montana.....	64, 043	4, 397	2, 868	6, 799	12, 297	7.6	-----	11.7	.1
Nevada.....	551, 148	8, 311	8, 477	72, 756	2, 720, 994	4.7	.2	41.5	49.6
New Mexico.....	3, 000	873	140	-----	-----	2.7	-----	-----	-----
Oregon.....	3, 369	2, 767	728	-----	-----	25.3	2.4	-----	-----
South Dakota.....	⁴ 1, 422, 138	211, 921	51, 649	105, 445	37, 421	66.8	57.0	33.2	41.3
Texas.....	57, 475	-----	-----	381	970, 115	-----	-----	77.9	72.4
Utah.....	5	10	3	-----	-----	-----	-----	-----	-----
Washington.....	4, 881	3, 538	203	-----	-----	21.7	.2	-----	-----
Wyoming.....	100	33	17	-----	-----	100.0	32.1	-----	-----
Eastern States.....	200	54	16	-----	-----	3.2	-----	-----	-----
Value.....	7, 242, 870	684, 744	226, 352	365, 379	4, 242, 270	31.9	.4	17.0	7.3
1927:	-----	\$14, 154, 915	\$132, 416	\$7, 553, 054	\$2, 481, 728	-----	-----	-----	-----
Total.....	7, 741, 562	649, 044	195, 895	377, 833	4, 177, 848	30.8	.3	17.9	7.0
Value.....	-----	\$13, 416, 930	\$111, 072	\$7, 810, 501	\$2, 368, 840	-----	-----	-----	-----

¹ Philippine Islands excluded.

² Also concentrates treated in gold and silver mills; metal content included under "Bullion recovered from all sources." For details see p. 897.

³ Also 313,127 tons of sands and slimes from ore and concentrates amalgamated were treated by cyanidation.

⁴ Also 1,371,096 tons of sands and slimes from ore amalgamated were treated by cyanidation.

The great bulk of the ore treated in gold and silver mills was from Alaska, South Dakota, California, Colorado, and Nevada, and here the famous mines and mills of the Homestake, Mother Lode, Grass Valley, Treadwell, Cripple Creek, Tonopah, and Goldfield districts are especially noteworthy. Large numbers of smaller mills, however,

mark the wide distribution of gold mining in these regions and in many other scattered districts.

The total yield of gold by amalgamation in the United States in 1928 was 684,744 ounces, compared with 1,120,344 ounces in 1911, the first year for which figures are available. The important increases in 1928 over 1927 were in Alaska, California, Idaho, Montana, Nevada, Oregon, and South Dakota. The important decreases were in Arizona, Colorado, New Mexico, and Washington.

The output of gold by cyanidation in 1928 was 365,379 ounces, compared with 377,833 ounces in 1927 and 1,444,077 ounces in 1915, the year of largest recorded output. The only large increases in 1928 over 1927 were in Colorado, Montana, and Nevada; the largest decreases were in Arizona, California, and South Dakota. Nevada continued to lead in yield of silver by cyanidation, producing 64 per cent of the total in 1928, but falling off 303,949 ounces in output compared with 1927; the only notable gains in 1928 were in California, Colorado, and Texas.

Alaska, California, Idaho, New Mexico, Oregon, South Dakota, and Washington yielded more gold by amalgamation than by cyanidation, but cyanidation produced more gold than amalgamation in Arizona, Colorado, Montana, Nevada, and Texas, and it produced more silver in Arizona, California, Colorado, Montana, Nevada, and Texas. In Alaska, Idaho, New Mexico, Oregon, and South Dakota the recovery of silver by amalgamation exceeded that by cyanidation. In 1928 amalgamation produced gold and silver valued together at \$14,287,331, compared with \$10,034,782 produced by cyanidation.

QUICKSILVER AND CYANIDE USED

Figures showing the total quantities of quicksilver and cyanide used in the recovery of gold and silver in the United States in 1928 are not available. For details of the use of quicksilver in the amalgamation milling process and of cyanide in the cyanidation process the reader is referred to the mine reports for the several Western States.

A considerable quantity of quicksilver was used at gold dredges in Alaska, California, Colorado, Idaho, and Oregon, and also at placer mines operated by hydraulicking and sluicing. The following quantities of quicksilver were purchased for use at gold and silver mills in the States for which figures are available: Arizona, 67 pounds; Colorado, 2,460 pounds; Idaho, 402 pounds; Montana, 252 pounds; Nevada, 905 pounds; New Mexico, 20 pounds; South Dakota, 10,550 pounds; and Washington, 75 pounds.

Considerable cyanide is used at flotation mills as well as at gold and silver mills. Cyanide used at gold and silver mills in 1928 was mainly sodium cyanide; some cyanamid and a very small quantity of potassium cyanide were also used. Reduced to the equivalent of 96 to 98 per cent NaCN, the use at mines in the States for which figures are available was as follows: Arizona, 34,710 pounds; Colorado, 384,351 pounds; Montana, 73,728 pounds; Nevada, 776,570 pounds; South Dakota, 335,675 pounds; and Texas, 163,000 pounds. No cyanide was reported as consumed in New Mexico, Utah, Washington, or Wyoming.

The following table gives details of the use of cyanide in eight of the Western States during the last five years.

Potassium and sodium cyanide consumed at mills in eight Western States, 1924-1928

State and year	Number of mills using cyanidation process	Ore and old tailings treated (short tons)	Cyanide consumed (pounds) ¹		
			Total	Per ton of ore and old tailings	Per ounce of gold and silver
Arizona:					
1924.....	7	146,904	135,971	0.93	1.05
1925.....	6	59,840	84,600	1.41	1.66
1926.....	10	96,545	90,315	.94	1.03
1927.....	9	102,932	92,815	.90	1.47
1928.....	5	30,948	34,710	1.12	1.02
Colorado:					
1924.....	3	451,366	306,196	.68	1.70
1925.....	3	463,922	309,293	.67	1.75
1926.....	3	508,060	258,327	.51	1.49
1927.....	2	501,011	270,000	.54	1.19
1928.....	2	462,153	384,351	.83	3.01
Idaho:					
1924.....	3	336	950	2.83	1.05
1925.....	1	1,377	3,900	2.83	3.96
1926.....					
1927.....	1	23	(²)		
1928.....					
Montana:					
1924.....	9	39,776	84,770	2.13	.77
1925.....	6	42,572	54,684	1.28	.57
1926.....	6	22,205	43,000	1.94	.64
1927.....	4	21,730	36,308	1.67	1.08
1928.....	5	47,637	73,728	1.55	3.86
Nevada:					
1924.....	25	965,995	2,703,706	2.80	.36
1925.....	16	801,141	2,123,687	2.65	.41
1926.....	15	717,582	1,787,957	2.49	.41
1927.....	22	446,869	1,105,600	2.47	.36
1928.....	18	527,511	776,570	1.47	.28
New Mexico:					
1924.....	1	72,736	112,500	1.55	.195
1925.....	1	52,118	81,159	1.56	.18
1926.....	1	750	1,125	1.50	.16
1927-28.....					
South Dakota:					
1924.....	3	1,647,344	361,650	.22	2.86
1925.....	3	1,567,555	347,242	.22	2.79
1926.....	3	1,402,472	299,672	.21	2.35
1927.....	3	1,353,298	312,626	.23	2.03
1928.....	3	1,376,205	335,675	.24	3.18
Texas:					
1924.....	1	84,744	70,995	.84	.10
1925.....	1	72,685	43,691	.60	.08
1926.....	1	33,818	24,375	.72	.06
1927.....	1	48,190	96,813	2.01	.12
1928.....	1	57,475	163,000	2.84	.17

¹ Partly estimated.

² Quantity small; figures not available.

REVIEW BY STATES

ALASKA

Gold.—The total estimated production of gold from Alaska mines for the period 1880 to 1928, inclusive, is given by the United States Geological Survey as \$373,080,000. The mine production in 1928 was \$6,845,000, which was \$918,000 more than in 1927. The yield from lode mines increased from \$2,945,000 in 1927 to \$3,498,000 in 1928, and that from placer mines increased from \$2,982,000 in 1927 to \$3,347,000 in 1928. The 26 dredges operated produced \$2,185,000 of the placer output; this was \$445,000 more than that yielded by 28 dredges in 1927. The increased output from dredges was mainly due to the operations of two new dredges in the Fairbanks district; it is expected that the output from dredges in this district will again increase in 1929. The average recovery of gold by the dredges in

1928 was about 34 cents per cubic yard of gravel, compared with 29 cents in 1927. The 3,736,500 tons of siliceous ore treated in 1928 yielded an average recovery of \$0.95 in gold and silver to the ton, which is a higher recovery than that in 1927. In 1928 about 51 per cent of the gold came from siliceous ore, compared with 50 per cent in 1927. The estimated recovery of gold from dredges for the period 1903 to the end of 1928 is \$36,075,474.

Silver.—The mine production of silver in Alaska in 1928 was 454,700 fine ounces. Copper ore yielded 350,430 ounces, siliceous ore 80,340 ounces, and placer bullion 23,930 ounces. Most of the silver from Alaska mines is contained in concentrates recovered from copper ore; the decrease in silver recovered in 1928 was entirely due to the decreased output of copper ore. The quantity of silver recovered in Alaska from placer bullion and from mill bullion is unusually small compared with the gold content.

ARIZONA

Gold.—The mine production of gold from Arizona mines in 1928 was \$3,967,488, of which only \$6,400 was from placers. Of the production from lode mines (\$3,961,088) 12 per cent was from dry and siliceous ore, 84 per cent from copper ore, 2 per cent from lead ore, and 2 per cent from other classes of ore. Yavapai County made an output of \$1,404,620 and Cochise County \$1,306,007. None of the other counties produced as much as \$400,000. The gold recovered from ore and old tailings by amalgamation and cyanidation was valued at \$298,149, which was much less than in 1927. The gold recovered from concentrates was valued at \$1,036,285, and that from crude ore shipped to smelters was valued at \$2,624,744. The crude copper ore directly smelted amounted to 2,674,321 tons and yielded an average of about 91 cents in gold a ton.

Silver.—Of the mine production of silver in Arizona in 1928 (6,791,351 ounces) 5,885,625 ounces came from copper ore, 486,842 ounces from siliceous ore, 263,130 ounces from lead ore, and 155,754 ounces from other ores and from placers. Yavapai County produced 2,619,217 ounces, Cochise County 2,172,954 ounces, and Pinal County 1,133,942 ounces. The output of silver in these three counties came chiefly from copper ore. Silver recovered from gold and silver ores by cyanidation and amalgamation amounted to 20,379 ounces, concentrates yielded 1,886,318 ounces, and crude ore shipped to smelters yielded 4,871,856 ounces. The larger silver-producing mines were the United Verde, Calumet & Arizona, Magma, Copper Queen, and United Verde Extension.

ARKANSAS, MISSOURI, OKLAHOMA, ILLINOIS, AND KENTUCKY

The lead, zinc, and lead-zinc mines of the Central States do not report any recovery of gold, and few report any silver. None of the zinc ores of Illinois, Kansas, Oklahoma, or Wisconsin yield silver; the lead concentrates of the Joplin region contain an average of only about one-tenth of an ounce of silver a ton and this silver is never recovered. The copper ore of southeastern Missouri contains some silver, but no copper ore was sold in 1928. All the silver (176,840 ounces) from southeastern Missouri in 1928 was derived from lead ore. A little of this silver was obtained in refining lead bullion and from copper-lead matte shipped to smelters, but most of it was con-

tained in zinc flotation concentrates, derived from lead ores, which were treated at retort zinc smelters, the residues from which were shipped to lead smelters. The zinc concentrates carry from 18 to 20 ounces of silver a ton. The lead-fluorspar deposits of the Kentucky-Illinois region carry silver; 3,146 ounces of silver was recovered from galena concentrates from this source in 1928. The galena concentrates from Illinois yielded 5.34 ounces of silver a ton in 1928. No silver was reported in 1928 from ores from Oklahoma or Arkansas mines; the properties have been idle or are abandoned.

CALIFORNIA

Gold.—The total production of gold from California mines for the period 1848 to 1928, inclusive, is recorded as \$1,823,562,360, of which \$1,226,915,404 was from placer mines. In 1928 the lode mines of California produced \$5,934,686 (an increase of \$100,981), of which gold quartz yielded 94 per cent, and the placers produced \$4,850,629 (a decrease of \$986,684). Of the placer production \$4,430,913 was recovered by dredging. The total dredge production from 1896 to the end of 1928 was \$159,964,684, and the output from dredges in 1928 was 41 per cent of the gold production of the State in 1928. The seven Yuba County dredges made the largest output, \$2,282,454, although their yield decreased \$1,177,679 from that of 1927. Eight dredges in Sacramento County made an output of \$1,505,724, an increase of \$294,446. Dredges in Butte County made an output of less than \$25,000 in 1928, while dredges in Trinity County made an output of more than \$333,000. Dredges were also operated in Calaveras, Shasta, and Stanislaus Counties.

Four of the 32 counties reporting mine production of gold had a yield of more than \$1,000,000 each in 1928. Of these Sacramento and Yuba Counties obtained most of their gold by dredging; Amador County is on the Mother Lode; and Nevada County produced gold mainly from siliceous ore of the Grass Valley district. The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—whose output is mainly gold milling ore, in 1928 produced \$1,977,136 in gold from mill bullion and \$484,839 from concentrates derived from gold ore, compared with \$1,903,002 from mill bullion and \$370,858 from concentrates in 1927.

Silver.—The total output of silver from California mines for the period 1848 to 1928, inclusive, is recorded as 81,737,052 fine ounces, valued at \$69,637,572. Of the silver output in 1928, siliceous ore yielded 1,006,138 ounces, copper ore 413,326 ounces, lead ore 39,443 ounces, copper-lead ore 2,653 ounces, and placer bullion 17,211 ounces. The only counties producing more than 100,000 ounces in 1928 were Mono, Plumas, and San Bernardino. Sixty-four per cent of the silver was recovered from ore sent to concentrating plants.

COLORADO

The total production of gold from Colorado for the period 1858 to 1928, inclusive, is estimated at \$706,000,000 and that of silver at 649,000,000 fine ounces.

Gold.—The mine production of gold in Colorado in 1928 was \$5,304,876, an increase of \$25,758 compared with 1927. The Cripple Creek district in Teller County produced \$3,059,181; that part of

the San Juan region including Dolores, La Plata, Ouray, San Juan, and San Miguel Counties, \$1,192,007; and Lake County, \$244,766. Rio Grande County (which has produced \$484,908 in the last three years) produced \$245,579 in 1928, an increase of \$112,049 over 1927, due to a revival of mining in the Summitville district. This district was discovered in 1870, and in the early days of mining in Colorado Rio Grande County ranked third as a producer of gold in the State. The mines in the other counties of the State produced a total of only \$563,343 in gold in 1928. The gold produced from placer mines in 1928 was only \$61,406, while that from lode mines was \$5,243,470; a dredge in Summit County yielded nearly all the gold from placers. Dry and siliceous ore, aggregating about 62.7 per cent of all ore treated, yielded 238,319 fine ounces of gold, or 93 per cent of the total yield of gold; lead-zinc ore yielded 5.1 per cent; and all other kinds of ore 2 per cent. The quantity of gold recovered by amalgamation and cyanidation was 184,373 ounces, that contained in concentrates was 49,062 ounces, and that in crude ore shipped to smelters 20,218 ounces.

Silver.—The output of silver from Colorado mines in 1928 was 4,052,253 ounces, or 267,648 ounces more than in 1927. Of this output Lake County mines produced 378,800 ounces; mines in the San Juan region, including Mineral County, 2,128,000 ounces; and those in Saguache County 903,759 ounces. Siliceous and dry ores yielded 57 per cent of the silver, lead ore 6 per cent, and lead-zinc ore 31 per cent. Only 211,670 ounces of silver was recovered in bullion at gold and silver mills and 779,254 ounces from crude ore shipped to smelters. A large part of the silver, 3,060,601 ounces, was derived from concentrates mainly from Saguache, San Juan, and San Miguel Counties.

IDAHO

The total production of gold in Idaho from the discovery of placer gold in 1863 to the end of 1928 is estimated at \$136,648,345 and the total output of silver for the same period at 307,612,976 ounces.

Gold.—Of the total output of gold in Idaho in 1928, valued at \$433,703, Boise County produced \$233,407 and Elmore County \$93,364. The value of the placer gold produced in 1928 was \$169,336 and that from lode mines \$264,367. Of the placer gold \$133,418 was recovered by three dredges. The total value of gold recovered by dredges during the period 1897 to 1928, inclusive, was \$6,026,932. Of the total gold in 1928, 39 per cent came from placers, 53.4 per cent from dry and siliceous ores, and about 7.6 per cent from lead ore, copper ore, and lead-zinc ore. Of the gold recovered from ore about 66 per cent was recovered by amalgamation.

Silver.—Of the 1928 output of silver (8,998,330 ounces) 8,513,048 ounces was from the Coeur d'Alene region in Shoshone County. The only other counties that produced more than 100,000 ounces of silver in 1928 were Blaine and Custer. Lead ore yielded more than 51 per cent of the silver in 1928, lead-zinc ore nearly 33 per cent, copper-lead ore nearly 13 per cent, copper ore 3 per cent, and all other classes of ore less than 1 per cent. Concentrates shipped yielded 8,010,023 ounces and crude ore shipped to smelters 982,286 ounces. Very little silver was obtained from placer and mill bullion. The largest producers of silver were the Bunker Hill & Sullivan, Morning, Hecla, and Sunshine mines.

MICHIGAN

The copper mines of Michigan produced only 17,153 ounces of silver in 1928, part of it from lumps of native silver picked from ore mined but mainly from the electrolytic refining of copper. The silver recovered from Michigan copper mines has decreased greatly in recent years. The output in 1927 was 97,193 ounces.

MONTANA

The total production of gold from Montana for the period 1904 to 1928, inclusive, is recorded as \$74,777,885, and the total silver production for the same period as 312,393,608 ounces.

Gold.—No gold dredges were operated in Montana in 1928, and the production of placer gold again declined. The output from placer mines was \$17,884, compared with \$22,325 in 1927. The value of the gold from lode mines in 1928 was \$1,185,136, compared with \$1,084,471 in 1927. Silver Bow County produced nearly one-half of the total output of gold; Lewis and Clark and Madison Counties were the only others that produced more than \$25,000. The gold was derived mainly from copper ore, which yielded \$693,464; siliceous ore yielded \$382,266, lead-zinc ore \$88,953, and all other ores combined less than \$21,000. At amalgamation and cyanidation plants 11,196 ounces of gold was recovered. Concentrates from all sources (mainly copper concentrates) yielded 39,665 ounces of gold, and crude ore shipped to smelters yielded 6,023 ounces.

Silver.—The total production of silver from Montana mines in 1928 (10,853,276 ounces) was 346,801 ounces less than in 1927. Copper ore yielded 5,705,513 ounces, or more than half the silver; lead-zinc ore yielded 4,108,498 ounces; copper-lead ore 402,705 ounces; siliceous ore 340,876 ounces; and zinc ore, lead ore, and placer bullion the remainder. Silver Bow County produced 9,558,619 ounces, or about 100,000 ounces less than in 1927. Cascade and Granite Counties were the only other counties that produced more than 100,000 ounces. Bullion from mills contained only 15,165 ounces of silver and crude ore smelted only 485,863 ounces. Nearly all the rest of the silver recovered was derived from ore and old tailings concentrated. The 699,796 tons of concentrates recovered from all sources in Montana in 1928 yielded an average of 14.7 ounces of silver a ton.

NEVADA

The total production of gold from Nevada for the period 1904 to 1928, inclusive, is recorded as \$205,827,266, and the total silver production as 241,073,324 ounces.

Gold.—The mine production of gold in Nevada in 1928 was \$3,620,833; of this only \$38,266 was from placer mines (no gold dredges were operated in 1928), an increase of \$866 over 1927. The larger producing counties were White Pine County with \$1,450,213, mainly from copper ore; and Elko County with \$592,196, Nye County with \$588,010, and Esmeralda County with \$522,444, all mainly from siliceous ore. The gold production of White Pine County increased \$453,761 in 1928, and that of Storey County (Comstock) decreased \$55,248. The proportion of the total gold that came from siliceous ore again declined; it was 63 per cent of the total in 1927 and only 57 per cent in 1928. Copper ore yielded 31 per cent of the gold in 1927 and 39 per cent in 1928.

Silver.—The mine production of silver in Nevada in 1928 was 5,481,574 ounces. The Tonopah district produced 1,900,315 ounces, or 267,379 ounces less than in 1927; Storey County produced only 37,679 ounces, compared with 62,051 ounces in 1927; and Esmeralda County produced 796,074 ounces, or 320,984 ounces less than in 1927. Dry and siliceous ore yielded 54 per cent of the silver and lead and copper-lead ores 38 per cent. Nearly 50 per cent of the silver was recovered by cyanidation, nearly 35 per cent from concentrates, and 15 per cent from crude ore shipped to smelters.

NEW MEXICO

Gold.—The gold produced by mines in New Mexico in 1928 was \$680,360, or \$75,877 more than in 1927. San Miguel County with \$309,697 was the largest producer; the gold was recovered from lead-zinc ore concentrated at the Pecos mill near Glorieta. Hidalgo County mines produced \$217,687 and those in Grant County \$116,281. Copper ore yielded 16,482 ounces, lead-zinc ore 15,045 ounces, and dry and siliceous ore 1,165 ounces. Concentrates yielded 20,519 ounces and crude ore shipped to smelters 11,455 ounces. The output from placer mines was \$1,347 in 1928, compared with \$5,808 in 1927.

Silver.—The mine production of silver in New Mexico decreased from 890,083 ounces in 1927 to 827,793 ounces in 1928. San Miguel County with 495,930 ounces, Hidalgo County with 122,171 ounces, and Grant County with 153,453 ounces were the only counties that produced more than 100,000 ounces in 1928. Siliceous ore yielded 26,104 ounces, lead-zinc ore 552,699 ounces, copper ore 197,389 ounces, and lead ore 51,584 ounces. Most of the silver was derived from concentrates of copper ore and lead-zinc ore. The concentrates treated yielded 625,670 ounces and crude ore shipped to smelters 201,966 ounces.

OREGON

Gold.—The placer mines of Oregon produced \$120,525 in gold in 1928, or \$63,172 less than in 1927. The output from lode mines was \$105,443, a decrease of \$14,243 from 1927; 95 per cent of it was obtained from siliceous ore. Lode and placer mines in the western district yielded \$131,540 in gold and those in the eastern district \$94,428. Of the total placer gold dredges in Grant and Jackson Counties produced \$90,103 and drift, hydraulic, and sluice mines in Baker, Coos, Curry, Grant, Jackson, Josephine, and Malheur Counties yielded \$30,422. The total output of gold in Jackson and Grant Counties in 1928 was \$56,636 and \$81,862, respectively.

Silver.—Of the total production of silver in Oregon in 1928, 22,042 ounces came from siliceous ore, 4,104 ounces from copper ore, 3,999 ounces from lead ore, and 779 ounces from placer bullion.

SOUTH DAKOTA

The total value of gold produced in South Dakota from 1876 to 1928, inclusive, is recorded as \$274,256,123, and the total output of silver for the same period as 7,579,646 ounces.

Gold.—The mine production of gold in South Dakota in 1928 was \$6,560,805, or \$96,182 less than in 1927. The output was derived

almost wholly from low-grade siliceous milling ore. Nearly 67 per cent of the total output was recovered by amalgamation and 33 per cent by cyanidation. The Homestake mills treated 1,416,949 tons of ore from the Homestake mine; receipts from gold-silver bullion product amounted to \$6,566,785. Only 2 ounces of gold were obtained from material smelted and 11 ounces from placer mines.

Silver.—The output of silver from South Dakota mines in 1928 was 90,547 ounces which, with the exception of 1,477 ounces, was derived from gold-silver bullion produced at mills.

SOUTHERN APPALACHIAN AND EASTERN STATES

Gold.—The total production of gold from 1799 to the end of 1928 in the southern Appalachian States, as shown by data compiled by the Bureau of the Mint and the Bureau of Mines, is \$51,151,252. The data compiled credit Alabama with \$766,746, Georgia with \$17,845,084, Maryland with \$71,405, North Carolina with \$23,663,453, South Carolina with \$5,182,815, Tennessee with \$323,313, and Virginia with \$3,298,436.

The mine production of gold in the Eastern States and in the southern Appalachian States in 1928 was \$35,097, compared with \$17,074 in 1927. Of this amount \$820 was obtained from small placer mines in Georgia, North Carolina, South Carolina, and Tennessee. The lode mines yielded \$34,277 in gold, of which only \$1,120 was from siliceous ore, mined in Georgia and North Carolina. Copper ore from the Ducktown district in Tennessee and from Swain County in North Carolina yielded \$12,651 in gold, and pyritiferous magnetite ore from Lebanon County, Pa., yielded \$20,506 in gold. No gold content was reported from zinc or zinc-lead ores in 1928. Some new mills and some development at siliceous lode mines were reported, and the output from siliceous ore may increase considerably in 1929.

Silver.—Siliceous ore and placer bullion yielded only 19 ounces of silver in 1928. Copper ore and copper concentrates, including concentrates derived from pyritiferous magnetite, yielded 102,501 fine ounces of silver; the silver content of the crude ore was only 0.054 ounce a ton.

TEXAS

The total output of gold from Texas mines from 1885 to 1928, inclusive, is recorded as \$64,986 and the output of silver for the same period as 21,362,768 ounces.

Gold.—The production of gold has been mainly a by-product. The mine output in 1928 was \$10,115, the largest production in many years. It came principally from Presidio County.

Silver.—The production of silver in 1928 was 1,340,622 ounces, an increase of 305,756 ounces over 1927. The Presidio mine in Presidio County, operated by the American Metal Co., produced 90 per cent of this total. The Hazel mine in Culberson County, first opened in 1883 and credited with intermittent production up to 1917, was reopened in 1928 by the World Exploration Co.; after July the company shipped siliceous silver-copper ore from the underground workings. This ore and that shipped to the El Paso smelter by lessees from the dumps of the Hazel mine contained more than 125,000 ounces of silver, or 9 per cent of the State total.

UTAH

The total output of gold from Utah mines from 1864 to 1928, inclusive, is recorded as \$126,269,939 and the total output of silver for the same period as 546,462,393 ounces.

Gold.—In 1928 the mine production of gold, nearly all from lode mines, was \$4,394,001, an increase of \$385,550 over that in 1927. Of the 1928 production the Tintic district yielded \$711,252, the Bingham or West Mountain district \$2,910,882, and the Park City district \$542,308. About 54 per cent of the Utah gold was derived from copper ore, more than 20 per cent from lead-zinc ore, 12.6 per cent from lead ore, and 12 per cent from dry and siliceous ore. The recovery of gold from concentrates was 155,507 ounces and that from crude ore shipped to smelters 53,035 ounces. Very little gold bullion has been produced at mills at Utah mines in recent years.

Silver.—The mine production of silver in Utah was 17,072,852 ounces, or about 1,534,100 ounces less than in 1927. The output of mines in Juab County was 2,339,009 ounces, in Salt Lake County 3,762,697 ounces, in Summit County 3,679,405 ounces, in Utah County 3,913,411 ounces, and in Wasatch County 3,066,421 ounces. The Tintic district produced 6,232,602 ounces, the Bingham district 3,728,942 ounces, and the Park City district 6,745,826 ounces. Lead-zinc ores yielded 41.6 per cent of the total, lead ore 36.6 per cent, siliceous ore 13.8 per cent, and copper ore 7.5 per cent. Crude ore shipped to smelters yielded 7,768,566 ounces of silver and concentrates 9,045,020 ounces.

WASHINGTON

The total production of gold in Washington from 1860 to the end of 1928 is recorded as \$30,258,099 and the total production of silver as 9,204,682 ounces.

Gold.—The mine output of gold in 1928 was \$337,167, or \$66,213 less than in 1927. The largest county production (\$258,798) in 1928 was from Ferry County, all from the Republic district. Mines in Whatcom County produced \$72,404 in gold, compared with \$86,822 in 1927. Most of the gold (\$332,772) came from siliceous gold ore. Copper ore yielded \$2,418, placers \$1,878, and other ores a total of \$99. Crude ore shipped to smelters yielded \$259,955, ore treated by amalgamation \$73,136, and concentrates \$2,198. The three largest producers of gold in 1928 were the Quilp, Boundary Red Mountain, and Surprise-Lone Pine-V Fraction-Pearl mines.

Silver.—Of the mine production of silver in 1928 (99,738 ounces) 65,198 ounces was from mines in Ferry County, all from siliceous ore. The output of silver from copper ore was 22,937 ounces, from siliceous ore 70,191 ounces, and from lead ore 5,414 ounces; the remainder came from lead-zinc and copper-lead ore and from placer bullion. Crude ore shipped to smelters yielded 88,438 ounces of silver, concentrates 11,067 ounces, and ores amalgamated 203 ounces.

WYOMING

The total production of gold in Wyoming from 1867 to the end of 1928 is recorded as \$1,239,501 and the output of silver for the same period as 70,171 ounces.

The mine production of gold in 1928 was \$677 and that of silver 53 ounces.

PHILIPPINE ISLANDS

Gold.—The output of gold in the Philippine Islands from 1907 to 1928, inclusive, is recorded as \$25,274,895. The production during the last 10 years was as follows:

1919-----	\$1, 309, 722	1924-----	\$1, 651, 796
1920-----	1, 276, 561	1925-----	1, 945, 990
1921-----	1, 313, 096	1926-----	1, 925, 188
1922-----	1, 526, 400	1927-----	1, 686, 231
1923-----	1, 686, 327	1928-----	1, 904, 062

The yield of gold in 1928 from lode mines producing siliceous ore was \$1,902,750. The gold derived from placers, nearly all from dredging, was \$1,312.

Silver.—The mine production of silver in 1928 (37,427 ounces) was derived entirely from gold bullion refined, and of this 37,409 ounces was obtained from ores milled.

An article⁵ was published in 1927 giving data on operations by the Benguet Consolidated Mining Co., the Balitoc Mining Co. (now controlled by the Benguet), the Itogon Mining Co., and the Ukup Mining Co., as well as development work done at other properties.

The annual report of the Benguet Consolidated Mining Co.⁶ for 1928 states that the bullion recovered was \$1,358,964, the gross profit \$678,719, and the net profit \$619,037. A 100-ton mill was constructed at the Balitoc property. A new hydroelectric power plant which supplies 1,000 kilowatts was built to supplement the old plant which supplied 1,130 kilowatts. Early in 1928 the Benguet mill was treating 8,000 tons of ore monthly, and ore reserves were estimated at 290,929 tons.

The larger producers of gold from lode mines, other than the Benguet and Balitoc, were the Syndicate Mining Co., Panigue Mines, and Geringer, Ashurst & Co., all at Aroroy, Masbate Province, and the Itogon Mining Co., Baguio, Mountain Province district.

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⁵ Eye, C. M., Philippine Gold Mining in 1926: Eng. and Min. Jour., Mar. 5, 1927, p. 414.

⁶ Engineering and Mining Journal, May 4, 1929, p. 738.

